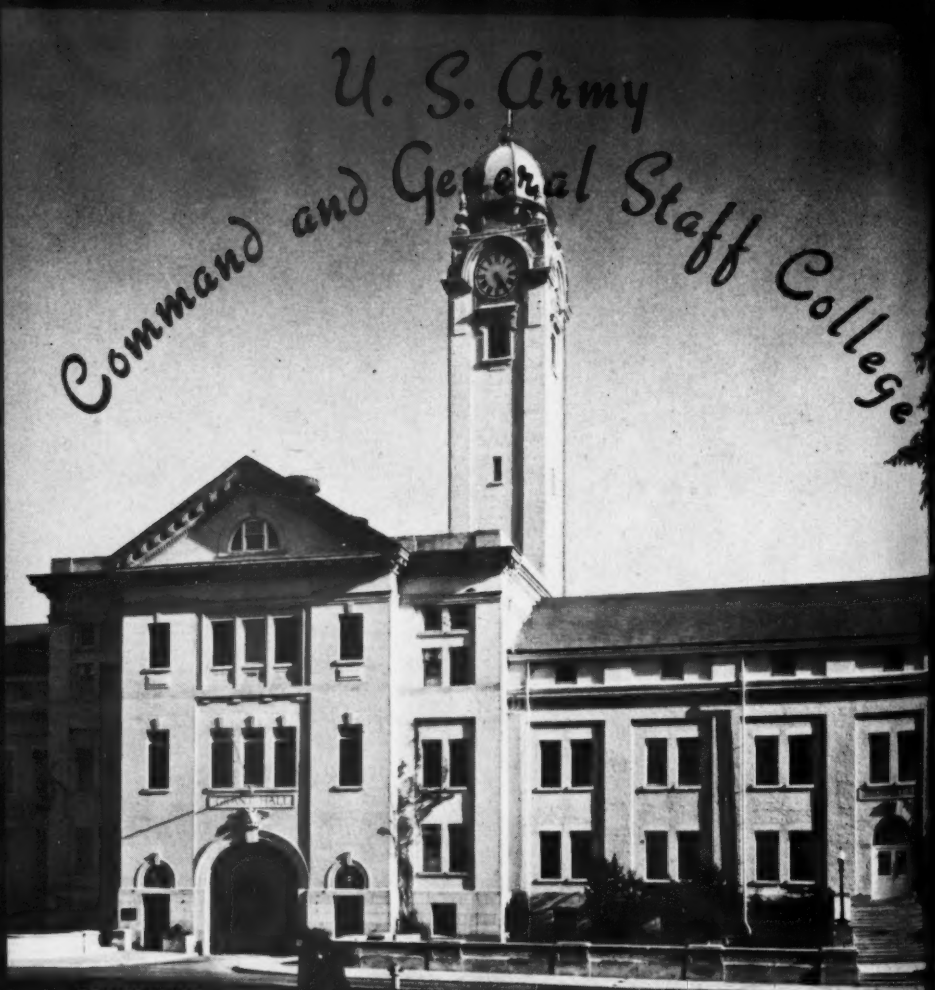
MILITARY REVIEW

U.S. ARMY COMMAND AND GENERAL STAFF COLLEGE
FORT LEAVENWORTH, KANSAS

AUGUST 1958 VOLUME XXXVIII NUMBER 5



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POLICY.

Unless otherwise indicated, the views expressed in the original articles in this magazine are those of the individual authors and not necessarily precisely those of the Department of the Army or the U. S. Army Command and General Staff College.

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The printing of this publication has been approved by the Director of the Bureau of the Budget 19 June 1956.

MILITARY REVIEW—Published monthly by U. S. Army Command and General Staff College, Fort Leavenworth, Kansas, in English, Spanish, and Portuguese. Entered as second-class matter August 31, 1934, at the Post Office at Fort Leavenworth, Kansas, under the Act of March 3, 1879. Subscription rates: $3.50 (US currency) a year in the United States, United States military post offices, and those countries which are members of the Pan-American Postal Union (including Spain): $4.50 a year in all other countries.

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THE NEGLECTED DETERRENT

Colonel R. W. van de Velde, *United States Army, Retired*

THERE has been far too little discussion and study of the capabilities and limitations of guerrilla warfare. Relative to almost any other aspect of military activity, there have been very few books or articles written, either in the professional or in the "popular" vein on this subject. One must search library catalog files and indices to periodical literature with considerable diligence to turn up even a few references. One obvious reason for this is, of course, that past guerrilla actions and campaigns do not lend themselves to ready study and analysis by military historians or military students.

The hit-and-run and will-of-the-wisp nature of successful guerrilla actions, coupled with the legendary type of exaggeration which grows up about them, make it extremely difficult to find the necessary background material for study and for writing. Virgil C. Jones, in an article, "Problems of Writing About the Guerrillas," which appeared in *Military Affairs* in the spring of 1957, describes the difficulties which he encountered in obtaining material for writing his account of guerrilla activities in the Civil War which was published in book form under the title *Gray Ghosts and Rebel Raiders.* Mr. Jones describes the elusiveness and fragmented nature of the source material which he sought so diligently. To the sparsity of information about guerrilla actions in the Civil War, Mr. Jones ascribes as a reason, "The guerrilla, or so-called irregular soldier, was given little recognition by the academy-trained militarists of that day."

The fact of the matter is that this lack of "recognition" still exists. Aside from a mere handful of officers with actual experience in guerrilla actions, and the few officers assigned to Special Forces, the great bulk of our officers lack knowledge in guerrilla warfare and its potential for our security. This is true despite the valiant efforts of those few knowledgeable officers to disseminate, by official means, some of that knowledge throughout the officer corps. It also is true despite the efforts of a few writers, both military and civilian, to popularize the Special Forces and thereby to increase an understanding of what we as a nation could do to build this potential weapon.

About 1955 both *The New York Times* and *Newsweek* printed stories about the US Army Special Forces which had hitherto been fairly well-cloaked under a label of "classified" information. In the spring of 1956 *The Saturday Evening Post* published an article by M. L. Blair entitled, "The Toughest Outfit in the Army," and in July 1957 *The Reader's Digest* published J. G. Hubbell's article, "The Army's Deadliest Soldiers." The combined readership of these four publications must indeed be immense. Nevertheless, the impact of these stories which brought Special Forces and the entire question of guerrilla warfare out from under the classification cover

Guerrilla warfare is a relatively inexpensive weapon of great potential, equally adaptable to conventional or nuclear warfare. Its concurrent use with other operations early in hostilities should be planned for now

apparently failed to rouse any marked interest.

Increased Interest Required

A fairly careful perusal of military journals and periodicals of the last few years fails to show any evidence of real interest in this subject among professional military writers. This is more remarkable since such a perusal discloses a great mass of thinking on the subject of a possible "future look" of ground forces in the atomic age. There is evident an increasingly widespread agreement that future land forces must be small, highly mobile, and self-contained. A remarkable thing about the dearth of ideas relative to guerrilla warfare is that this type warfare is the logical ultimate in small, highly mobile, and largely self-contained fighting units. Not only is it difficult to exterminate guerrilla forces with nuclear weapons, but after a nuclear holocaust such as envisioned by the Strategic Air Command (SAC) strategists, guerrilla actions may be the only actions possible.

If they are the only actions possible, and we have reason to know that the Soviet and Red Chinese and their satellites are adept in this type warfare, then we had better take an interest in it from the point of view of countering the guerrillas. Major C. H. A. East, of the Australian Army, wrote an interesting article which appeared in the September 1957 issue of the *Military Review* in which he stated that no special counterguerrilla forces were necessary. This is probably true. On the other hand, we will never be able to contend with this type warfare unless we understand it. Major East's short article is helpful in this direction. He makes a further, and highly valid point, that whether or not guerrilla forces arise initially through Communist activity, the Communists are adept at seizing the eventual political control of the native guerrillas in any area where the Communists have even a slight foothold. Major East says:

The surest method by which such [eventual political] control can be retained is to provide the trained personnel and organization from the regular army to establish a formal guerrilla organization when hostilities begin.

Anyone who has studied the guerrilla actions of the last decade and a half should be in complete agreement with that statement. Our own Special Forces organization is a partial attempt to be ready in the event of another war.

This article will be confined to a discussion of the deterrent capability of an adequately developed US potential for guerrilla warfare. A specially assembled study group at Fort Leavenworth published its findings in the April and May 1957 issues of the *Military Review* under the title, "Readiness for the Little War." This article is a major contribution in sober and objective thinking about future defense problems and possibilities facing the United States. It should be required reading for every officer in each of our services.

The authors ascribed a role of deterrence to properly balanced military forces without in any way detracting from the

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Colonel R. W. van de Velde, United States Army, Retired, was graduated from Princeton University in 1933 and commissioned in the Regular Army in 1937. Among his assignments have been duty as Assistant Military Attaché in Greece, 1947-48; Military Attaché in Israel, 1948-49; and on the staff of the Chief of Psychological Warfare, 1953-55. He attended the U. S. Army Command and General Staff College in early 1943 and the Strategic Intelligence School in 1946-47. He holds a Master's degree in Public Affairs and a Ph.D. from Princeton where he studied International Relations from 1950 to 1953. Before retiring in 1957, he was in the Special Projects Branch, J3, Headquarters, US European Command. He currently is on the faculty of the Woodrow Wilson School of Public and International Affairs, Princeton University.

very necessary role of SAC as a deterrent to major war. Late in the article they briefly treat the question of unconventional warfare (which includes guerrilla warfare as one of its aspects). Thereby, one probably could say, they have implied a deterrent role to guerrilla warfare capability. But this type of brief treatment and implied relevance will not be enough to emphasize the use to which this Nation can put its capacity for guerrilla warfare, even if it never has to employ that capacity in actual combat.

Hungarian Revolt

In late 1956 the world was taken by surprise by the intensity and the sustained example of courage of the Hungarians' revolution against their Communist masters. We should not have been surprised at the disaffection itself, because students of the situation had been telling us for years that it existed. They had been saying repeatedly that it existed in varying degrees in all the satellites and possibly to some extent in parts of the USSR proper. Given the world situation in which it was set, the revolution was doomed to fail in attaining the immediate aims for which the Hungarians sacrificed themselves. Nevertheless, for various reasons, the revolution was not without possible profit. If nothing else, it was a lesson for the world, especially the free world. The US and the free world could not give the Hungarian people the military support which the rebel radio stations so frequently called for, and which free men everywhere wished they could give.

Imagine, however, that the Hungarian revolution had been in a setting of a world war already in progress. Instead of leaderless and planless groups giving their lives in noble but tragic frontal acts, suppose that there had been immediately parachuted onto the scene, Hungarian-speaking, trained military men, equipped with a plan and the necessary weapons. It is easy to visualize what havoc they could have wreaked on Soviet lines of communications through Hungary to Yugoslavia, to Austria, and to Czechoslovakia. With a plan, with weapons, with communications, and, above all, with the masses of courageous Hungarians fired by hate, the entire Soviet offensive would have bogged down. Add to this scene the destruction of bases, depots, and lines of communication in the USSR through strategic air attack. In such a situation even the superior numbers of Red troops would have been nearly helpless. Furthermore, given the chance for organized and planned action, it seems probable on the evidence that the entire body of the Hungarian armed forces would have joined the fight against the Red Army.

The situation just described presupposes that the war had been "limited" at least to the extent that only small tactical nuclear weapons had been employed. That this type of war may be a possibility is becoming more and more acceptable in the minds of military thinkers. If it had started as an all-out thermonuclear contest, the role of guerrilla forces which we might align with us would be modified, but not necessarily less important to us as a nation in combating whatever was left of the Soviet armed forces.

Under the circumstances of the Hungarian revolution of 1956, we could not help. To have given the necessary aid would almost surely have triggered off world war III. But war may come and it is the business of the military to be prepared for it. The spectacular achievements in scientific advances and military technology so much in the news of late should not blind us to the other aspects of the job of preparedness which is the responsibility of our Armed Forces. The riots in East Germany in 1953, the Polish uprisings such as that in Poznán in early 1956, and the Hungarian revolution in late 1956 certainly should prove to us what our intelligence people have been saying for years: that

a "resistance potential" does, in fact, exist behind the Iron Curtain.

In view of this, are we preparing to the full extent of our capacity if we ignore the uses to which this potential can most effectively be put? No one in his right mind would belittle the deterrent effect nor the war usefulness of modern weapons, but we should not let the roar of the IRBM's (intermediate range ballistic missiles) and the ICBM's (intercontinental ballistic missiles) as they take off into space so deafen us that our minds are no longer capable of thinking about the supplementary and complementary tactics and strategies available to us and which we should be prepared to employ.

Guerrilla warfare perhaps is the oldest form of warfare, but the US Army concept of Special Forces is a "new weapon" which belongs in the arsenal together with our other new weapons. The "newness" of Special Forces lies in its effort to have plans ready to use homegrown guerrillas at once on the outbreak of war. It is a new concept to have, in *being*, trained teams of men whose wartime mission is to infiltrate enemy areas by land, sea, or air with the predetermined objective of raising, training, and leading indigenous guerrillas.

Creative Thought Needed

General Willard G. Wyman, in a speech delivered to the annual meeting of the Association of the United States Army in 1956, stressed the necessity for creative thought among military men. Many have responded. Our military journals are full of thoughts, suggestions, and discussions concerning new ideas for waging war in the nuclear age. Most of this, of course, has been brought about by the development of the nuclear weapon and its subsequent modification into both larger and smaller weapons of tremendously destructive power. Much of it, to date, also has concerned itself with the speed of delivery of these weapons.

Jet propulsion, which really only came into its own after World War II, was tested fully in the Korean war. Guided missiles and ballistic missiles of relatively short range have, if not actually tested in battle, been assigned operationally to units in the field. Perhaps enough is known about these weapons already to make it possible to plan realistic changes in organizational structure and tactical employment of military forces. We now are on the threshold of being able to plan operations taking the supersonic IRBM's and ICBM's into account. Much study already has gone into the problem of what these space age delivery systems mean for the Military Establishment charged with the national security of the United States. Certainly, much more needs to be done.

As indicated earlier, thus far at least the only emerging principle evident to a student of the subject can be summed up in the words "greater dispersal, greater mobility, and greater self-sufficiency" of units. This principle seems to be equally applicable to the Air Force, to the Navy, and to the Army.

If this is true of our forces, it is equally true of those of our potential enemy. He, too, must protect his forces from nuclear attack and must do so largely by scattering them in small mobile units. But while such forces are less vulnerable to nuclear attack, they are far more vulnerable to harassment, delay, and eventual erosion by guerrilla bands. Lack of heavy weapons and equipment and lack of engineer support always has caused guerrillas to avoid direct assault on large military formations. They are most effective when they combine their attacks to points on lines of communication and to isolated and fairly small conventional military forces. While they must purposely avoid pitched battles with large forces, nevertheless, they have been highly effective in turning such forces away from their major objectives and primary goals.

General Eisenhower equated the assistance given by the French *maquis* to the Allied landings in France to the value of 15 divisions. Tito's partisans tied down an average of nearly 30 German divisions in Yugoslavia for years. Almost 200,000 Greek national troops were employed for approximately three years in quelling the Communist guerrillas in that country. It is fairly reliably estimated that the Greek guerrillas never at any time had more than about 30,000 men and women in their forces. The Philippines, Burma, China, Italy, Indochina, and Malaya, not to mention the USSR, in very recent history have attested the capability of guerrillas to harass, delay, and—sometimes totally and singlehandedly—defeat very much larger conventional forces.

New Methods

The age we live in is new to most of us. The greatest sources of power and of destruction, and the fastest means of delivering the weapons of destruction are new to us. Military planning and military writing in recent years have indicated that the vast majority of military men fully recognize that they *must* contend with new forces and new strategies. These are "big unknowns" with which it is only too obvious that we must wrestle. By comparison, guerrilla warfare appears to be a "little" unknown.

Perhaps it is not so much blindness toward the value of guerrilla warfare as an inherent distaste for the political implications. Throughout history guerrilla warfare usually seems to have had political overtones, and the average professional military man shrinks from politics. Actually, however, most wars have had political objectives, because war without political objectives is senseless slaughter. Politics is the structure through which humans arrange and control the social organizations in which they live. The object of war among civilized states is not to bring home heads or scalps; it is to achieve new and more favorable "political" arrangements.

Another cause of our reluctance to plan the employment of, and, therefore, to identify ourselves with, guerrilla formations is that in most recent history major guerrilla formations usually have been identified with a political movement which is most unpleasant to us—communism. But this need not always be so. As a matter of fact, that it was so at all can be attributed frequently to our own failures.

Pattern

There is an over-all pattern evident no matter what partisan or guerrilla movement of the immediate past one examines. First, guerrillas obviously are people who resent, and are willing to combat, the controlling power of the moment. In a sense this puts them outside the pale of organized society. In non-Communist countries this has meant that they automatically found themselves to be bedfellows of the openly dissident and hardier Communist elements of those countries. Second, the Communists, because of their head start in organization, discipline, and ability to plan, assumed active control of the resistance movements. And third, because of their highly developed propaganda machines, they have managed to equate communism with resistance to locally unpopular regimes.

If—but only if—we plan and prepare ahead of time, can we turn the tables on the Communists. The Communist empire is seething with disaffection and latent disloyalty. As previously indicated, Germany, Poland, and Hungary have proved this to be true. Competent observers feel that the brutal crushing of an entire population by the Soviets in the winter of 1956-57 has not ended resistance in the satellites and the USSR, but has more probably reawakened and strengthened it. If it also has made the resistance more wary and more apt to await the proper time, so

much the better for the West as well as for the captive peoples.

Certainly, the Soviets are fully aware of the powder keg under them. They now must know they cannot trust the satellite peoples, either civilian or military, as real allies. They also must be conscious that they may not be able fully to trust their own people or armies. This awareness is, in itself, a deterrent to any aggressive westward move they might want to make. It would be a still greater deterrent if, added to their knowledge of this internal vulnerability, they were reasonably certain that the US was militarily capable and ready to begin, on D-day, to organize, train, lead, and support the dissidents within the Communist empire.

If we assume that they now aspire toward some future D-day, the Soviets must take one of two measures to attempt to make loyal those whom they now know or suspect to be disloyal. They can attempt loosening the tight rein, as they appear to be doing in Poland, in an effort to win friendship. Or they can take brutally repressive measures as they did in Hungary, in an apparent attempt to stamp out every vestige of resistance. Neither measure will enhance the Soviet warmaking capability.

The method pursued in Hungary will cause a surge of still greater hate for the USSR which in time will become traditional and will be a part of every Hungarian child's cultural environment. Nor will this hate stop at the frontiers. There have been clear indications in other satellites that the West's shock and revulsion at Soviet actions in Hungary was shared by most east Europeans. One day even the toughest "Stalinist" in the Kremlin will recognize the negative value of wholesale barbarism against a civilized people in the heartland of civilized Europe.

The other alternative which the Soviets can follow—that of loosening their stranglehold—will equally reduce their warmaking potential. The more freedom a man has, the more he wants. The reins have been loosened a bit in Poland and there is continuing evidence that the Poles want more head. Gomulka, perhaps very wisely, has cautioned them against demanding too much, and he has used Hungary as an example of what might happen in Poland if the Poles should press too hard. It is probably sadly true that the Hungarians demanded too much too suddenly. But the fact is that the only way the Soviets can hope to assure the long term friendship of their present captives is to yield gradually to their continuing demands for national freedom. This is precisely one of the United States major objectives in the cold war.

A Free Europe

Not only for moral and humanistic reasons do we want these people to regain their national freedom, but we desire it for reasons of free world security. A coalition or alliance of *free* nations in east Europe, no matter how mutually friendly, cannot be an instrument of dictatorial aggression nor of surprise attack in the same way that the existing monolith could be.

The entire stream of history down to the present shows that multinational alliances, while often successful in defense when attacked, rarely have been successful in aggression. Defense against attack welds peoples and nations together in the commonalty of their immediate danger. Aggressive aims vary from nation to nation and from people to people. Their varying cultures and conditions, as well as their varying needs, hamper the ability of an alliance to reach a simultaneous decision to make the opening move in a common direction for a common goal. This initial freewill decision is the essence of aggression. The victims of aggression have their common decisions forced upon them.

The more truly free the present satellites become, the more the differences in

their cultures, in their aspirations, and in their needs will vary from those of the USSR and of each other, and the less likely will the Soviet-satellite bloc be able to reach the common decision necessary to open an aggressive war. Thus the very existence of the Special Forces is a cold war instrument of the US because it pushes the Kremlin into doing something political we want done about its own vulnerability—the built-in disloyalty of any people toward a ruthless regime. If war should come, through evil design or through miscalculation, the existence of Special Forces will help to assure the West's ability to win it—to win it, that is, if it is something less than all-out nuclear war. If the latter type of war should come, no one will "win," and it might be that our Special Forces and the guerrillas they may manage to bring about will constitute a large part of what is left of US influence in a shattered Europe.

To be most effective, however, it seems clear that our Special Forces must be ready for deployment on D-day. The first few days following even a preplanned Soviet attack will be a period of great confusion within the Soviet bloc, as it will be everywhere else. We must be ready to organize, guide, and support native guerrillas early enough to take immediate advantage of the inevitable disruption of routines in the economy, in police-state control systems, and in the distribution system following D-day. We must be prepared to lead satellite armed forces into wholesale defection before they become physically and spiritually committed to the battle the Soviets will have planned for them. To strike while the iron is really hot will mean to get our Special Forces teams to their assigned areas within a matter of hours after the initial Soviet attack opens the war.

To be prepared for this type action means greater knowledge by our own military of our Special Forces missions and requirements, and fuller acceptance of the role the Special Forces concept can and should play in the defense of the US and the West. For greater effect as a force to strike the Soviets' Achilles' tendon if war should come, but particularly for maximum effect as a deterrent to Soviet aggression, we have to stop hiding our Special Forces' light under the bushel of security wraps. With the publicity which has been given these forces in the past in at least four nationally and internationally read publications, it is obvious that Soviet intelligence is quite aware of their existence and their mission.

Increased Publicity

We are hurting only ourselves and lessening the potential of Special Forces, both as a deterrent to war and as an effective weapon if war should come, by not more fully publicizing this organization. Its effectiveness as a weapon will depend partly on our own acceptance and knowledge of its capabilities and limitations, and on the preknowledge which the dissident elements within the Soviet bloc have of our Special Forces, and on the hope which the existence of such an organization holds out for these elements in the event of war.

In addition, the deterrent effect of Special Forces, and what their existence implies as a means to organize guerrilla activity, will be far greater on the Kremlin leaders (who already know about them) if those leaders realize that the dissident elements within their empire also know about the Special Forces and may be counting on their arrival in the event of hostilities.

At a time when we are already spending over half our tremendous national budget on national defense, it is appropriate to say a word about the costs involved in special troops. It is true that the cost-per-man of training Special Forces is high. This is because of the many specialties each man must master. Each must have a language proficiency, each is a parachut-

ist, a skier, a mountain climber, and an expert in survival. They are masters of weapons and troop training techniques; they are radio communicators and repairmen and, above all, they must develop the well-founded self-confidence required of all leaders.

Balanced against the cost of developing such men is the size and power that relatively few such men can generate in terms of counterforce against the enemy. History shows that for each such trained leader-technician, we can expect up to 200 guerrillas to be trained and competently led.

General Alfred M. Gruenther a few years ago estimated that it takes about 10 men in conventional forces to nullify one guerrilla. Carrying the arithmetic one step further, this means that we can expect to tie down somewhere in the neighborhood of 2,000 enemy troops for each Special Forces man we train. Through what other arm or weapon costing only the price of highly training one soldier can we hope to counteract the effectiveness of nearly a regiment of the enemy?

The bulk of the future guerrilla force costs us nothing now in pay, training, housing, feeding, or clothing. Actually, the Soviet bloc is paying those costs for us. Because of the nature of the war they wage, the wartime support of guerrillas is relatively negligible too. This is a period when the mounting costs of armaments necessary to our security have many of our leaders worried. It would appear something less than wise or foresighted to neglect the potential of this inexpensive weapon. No one who knows anything about guerrilla warfare would contend that it should be relied on solely or to the total exclusion of even some one other weapon, even in limited warfare. What they will contend is that it is a weapon of great potential, particularly in the situation existing in the Soviet bloc; that it is a very inexpensive weapon; and that plans should be made for its use very early in hostilities. They also will say that it is most effective if used concurrently with other operations.

Conclusion

Perhaps a word about these "other operations" is in order. All of our leaders openly and repeatedly have said that a Soviet attack on us or on our allies will call for immediate retaliation. For several years past "massive retaliation" was the cornerstone of both our deterrence and our defense. Recently, more and more students of the subject have come to the conclusion that "selective" rather than "massive" retaliation may prove more effective. Whatever the form of retaliation, if our defense includes unconventional warfare in the form of guerrilla operations, then nuclear planning had better take into account Special Forces planning.

The United States is unlikely to raise friendly guerrillas among the survivors to be found in radioactive wreckage created by US nuclear weapons. If we want masses of dissident people to rise up and fight their Soviet oppressors under our guidance, if we want their armed forces to defect en masse, then we must plan to spare the satellites the type of massive nuclear destruction the Soviets would earn if they launched an attack on us. Furthermore, we should make the satellite peoples aware now that we do plan to treat them differently in the event of a future war. We should tell them why. This would strengthen the cold war deterrent and if, despite all deterrents, hot war should come, this announcement of policy would speed and facilitate the raising of guerrilla forces.

U. S. Army Ordnance Missile Command

Material for this article was furnished by Army Ordnance Missile Command, Redstone Arsenal, Alabama.—Editor.

THE U. S. Army Ordnance Missile Command embraces the key installations engaged in rocket, missile, and satellite programs in Alabama, California, and New Mexico.

Its resources and capabilities cover a wide range, from prototype production of the *Jupiter* IRBM, basic research in many areas, proving facilities, and the launching of long-range rockets.

Its programs include the entire family of Army rockets and missiles, from the antitank *Dart* to the *Jupiter C* which launched the first US earth satellite, *Explorer*.

The command extends from coast to coast, from the Jet Propulsion Laboratory in California to the Missile Firing Laboratory—a part of the Army Ballistic Missile Agency—at Cape Canaveral, Florida, where the long-range rockets are launched.

Agencies under the command are the Army Ballistic Missile Agency, the Army Rocket and Guided Missile Agency, the Jet Propulsion Laboratory, and White Sands Missile Range.

Army Ballistic Missile Agency

The Army Ballistic Missile Agency is America's first and only agency created exclusively for the performance of technical service responsibilities for long-range ballistic missile systems and orbital vehicles.

This encompasses research and development, fabrication of components, prototype production, static testing and launching, and resolution of logistics support and field maintenance problems.

Its facilities include a 500,000-pound thrust, twin vertical test stand, cold calibration stand, blockhouse, development shops, and assembly buildings capable of fabricating complete missiles; metallurgy, rubber, and plastics laboratories; and a computations laboratory and supporting facilities. The plant is ideally suited to the development and prototype production of large liquid fueled rockets.

Its programs include the Redstone Ballistic Missile System, the Jupiter IRBM System, the Pershing Missile System, and the earth satellite undertakings supporting the International Geophysical Year.

In training at the agency are the 40th Field Artillery Missile Group (Heavy), US Army, and the 864th Jupiter Missile Squadron, US Air Force.

Dr. Wernher von Braun directs the Development Operations Division, largest segment of the agency. The laboratories functioning under his supervision include: Aeroballistics, Computation, Fabrication and Assembly Engineering, Guidance and Control, Systems Support Equipment, Missile Firing, Research Projects, Structures and Mechanics, Systems Analysis and Reliability, and Test.

The agency is located on Redstone Arsenal. It maintains liaison offices at the Ballistic Missile Division, US Air Force, and at Patrick Air Force Base.

Its Missile Firing Laboratory is responsible for the launching of the largest Army

Responsibility for the Army's rocket and missile program, as well as Army outer space projects, is vested in the U. S. Army Ordnance Missile Command which encompasses activities located in three states

rocket missiles at Cape Canaveral, Florida.

Army Rocket and Guided Missile Agency

The Army Rocket and Guided Missile Agency is charged with development, procurement, production, industrial engineering, industrial mobilization, maintenance and repair part supply, and stock control of Ordnance rockets and guided missiles. This includes all Army surface-to-surface and surface-to-air missiles except the ballistic missiles for which the Army Ballistic Missile Agency is responsible.

Formerly known as Redstone Arsenal, the Army Rocket and Guided Missile Agency also is assigned specified national and support missions for other types of rockets, JATO's, and aerial target drones.

The Army Rocket and Guided Missile Agency organization has directed the development of such Army weapons systems as the surface-to-surface *Sergeant, Corporal, Dart, Honest John, Little John, Lacrosse,* and the *Redstone* guided ballistic missile which was complete and under test when the Army Ballistic Missile Agency took it over on 1 February 1956; and surface-to-air *Hawk, Nike Ajax, Nike Hercules, Nike Zeus,* and *Plato.* Some of these already are deployed and others are nearing field use.

Major elements of the agency include three divisions: Research and Development, Industrial and Field Service—which have the national Army missions in their respective fields—and the Ordnance Missile Laboratories, a series of labs which are devoted to research, development, and testing operations carried on within the confines of the arsenal.

Within the Research and Development Division is the Redstone Antimissile Missile Systems Office which is responsible for the *Nike Zeus* and *Plato* antimissile missile systems.

The Army Rocket and Guided Missile Agency's work in solid propellants is conducted on the arsenal by the Thiokol Chemical Corporation and the Rohm and Haas Chemical Company which operate government-owned facilities.

Physical facilities of the agency include test ranges which permit the firing of smaller caliber rockets, and static and environmental test facilities for larger solid propellant motors.

Jet Propulsion Laboratory

The Jet Propulsion Laboratory, a research and development facility, is operated by the California Institute of Technology for the Army.

It covers 80 acres near Pasadena, California, and is staffed by almost 2,000 professional and technical personnel provided by the institute. It has a threefold mission:

1. To originate, develop, and test new guided missile systems.

2. To conduct supporting research investigations in the physical sciences to acquire basic data applicable to weapon system development.

3. To undertake feasibility and evaluation studies of programs of special interest to the Nation.

It includes 20- and 12-inch supersonic wind tunnels, a third for hypersonic research is being constructed, and individual laboratory and associated facilities for fundamental research. Combination laboratory and test facilities provide for the application of basic research data to controlled tests. Processing units and test cells are available for propellant testing and evaluation. An instrumentation installation facilitates recording and reduction of test data.

Formal documentation of all aspects of various research and development projects is one of the chief products. There is a library of 150,000 volumes which is considered one of the most complete compendiums of scientific literature relating to jet propulsion and to other fields pertinent to guided missile development.

The laboratory has three external facili-

ties: a static testing area for testing large rocket motors at Edwards Air Force Base, Muroc, California; a field testing operational unit for missile flight test at White Sands Missile Range, New Mexico; and additional testing facilities at Patrick Air Force Base, Florida.

Perhaps its most publicized venture was the packaging and furnishing of some of the instrumentation for the *Explorer* satellite launched by a *Jupiter C* rocket from Cape Canaveral, Florida, 31 January 1958. The laboratory and the Army Ballistic Missile Agency developed the *Jupiter C*.

White Sands Missile Range

White Sands Missile Range is located in the Tularosa Basin of southcentral New Mexico, approximately 50 miles north of El Paso, Texas. Its name is derived from the National Monument, a 250-square-mile area of pure white gypsum sand within the reservation.

It is unique in that every branch of the armed services is represented. In addition to military personnel, civilian establishments—both academic and industrial—are located on the post. Covering 4,000 square miles, its primary mission is the testing of intermediate range rockets and guided missiles.

Included in this mission is the responsibility to execute all technical and engineering functions associated with flight testing of guided missiles, rockets, or other munitions assigned for testing, and for general supervision and coordination of scheduling, range safety, and instrumentation of all flight testing.

Each service has contributed in the construction of rocket testing facilities. All use the same firing range and, to a great extent, the same personnel in firing and instrumentation of rocket flights.

White Sands maintains appropriate scientific, technical, and services staffs and facilities to perform its assigned functions.

Responsibilities

Among the major weapons systems for which the Missile Command will have over-all responsibility are the giant ballistic missiles; *Redstone* and *Jupiter*; the oncoming *Pershing* solid propellant missile, which eventually will replace *Redstone*, and the surface-to-air missiles *Nike Hercules*, *Nike Zeus*, *Hawk*, and *Plato*; the *Sergeant*, *Honest John*, *Little John*, *Lacrosse*, *Dart*, and the *Corporal*, predecessor to *Sergeant*.

It will carry on the Army's outer space projects such as the earth satellite, *Explorer*.

Headquarters of the command will be located on Redstone Arsenal where Major General John B. Medaris, the officer named commanding general of the new organization, until now has headed the Army Ballistic Missile Agency.

The command integrates existing personnel and resources to permit the Army to continue its development of modern weapons with maximum efficiency and dispatch.

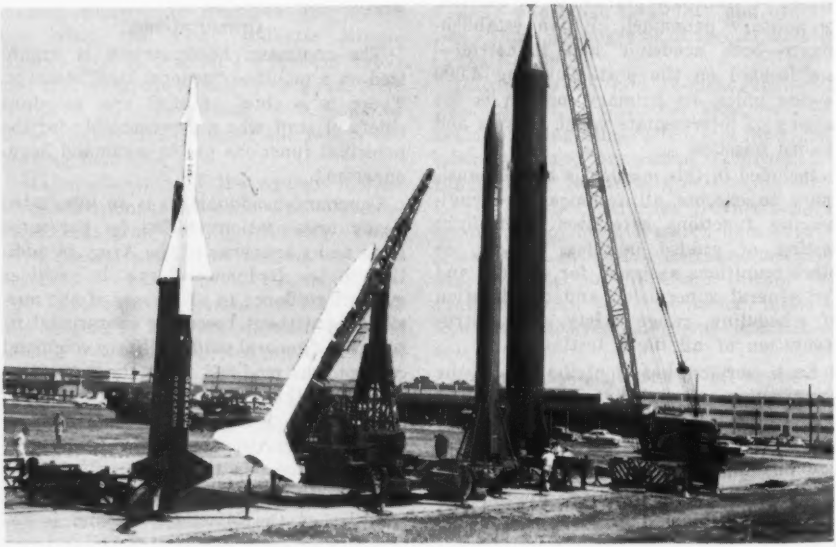
Organization

The command headquarters is organized on a modified "general staff" concept. There is a chief of staff and assistant chiefs of staff who are responsible for the principal functions of the command headquarters.

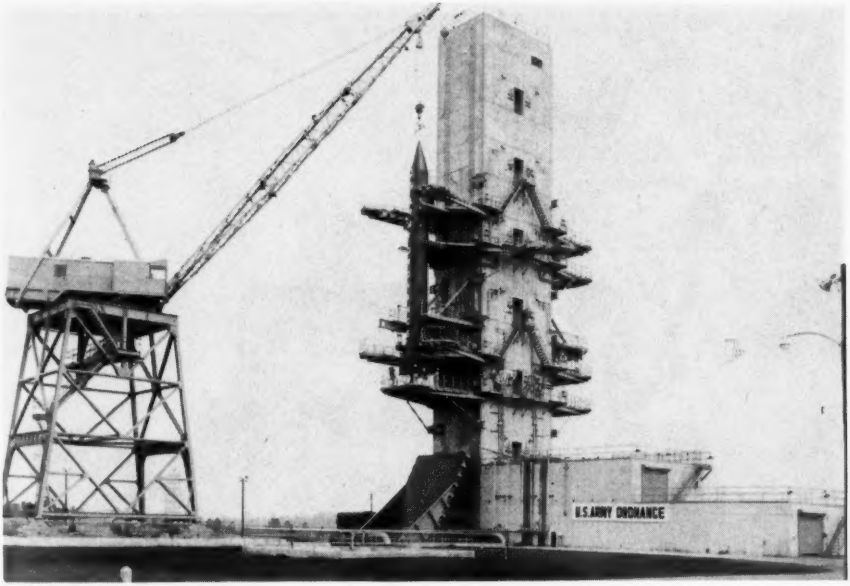
Command headquarters is an integrated Army organization staffed by personnel from many branches of the Army in addition to the Ordnance Corps. It provides over-all guidance in all phases of the missile field without becoming operational itself. The "general staff" military command concept was modified to fit the particular situation, that of an organization concerned with research, development, and industrial activities, plus the support of missile systems in the field.

An indication of the scope of responsibilities of the Missile Command is depicted in the following United States Army photographs.

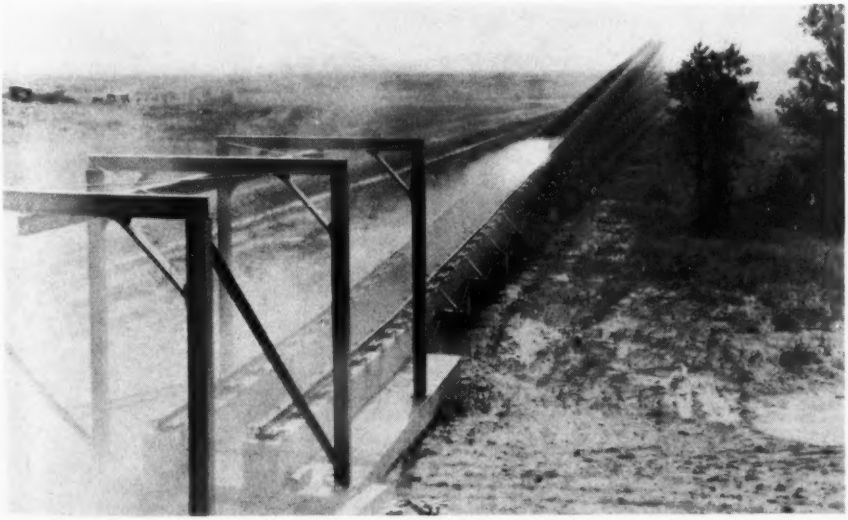
Headquarters Building, Redstone Arsenal, Alabama



Left to right above the *Nike Ajax, Honest John, Corporal,* and *Redstone* missiles

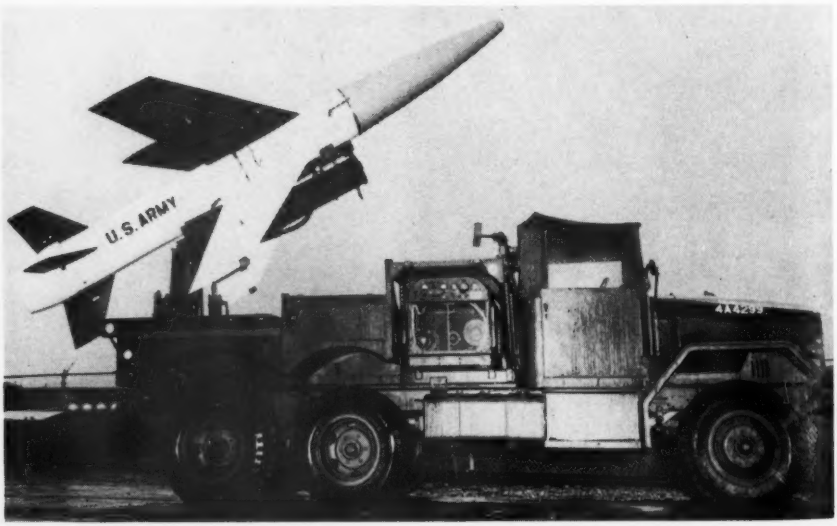


Largest static firing test stand for rocket motors in US is at Redstone Arsenal



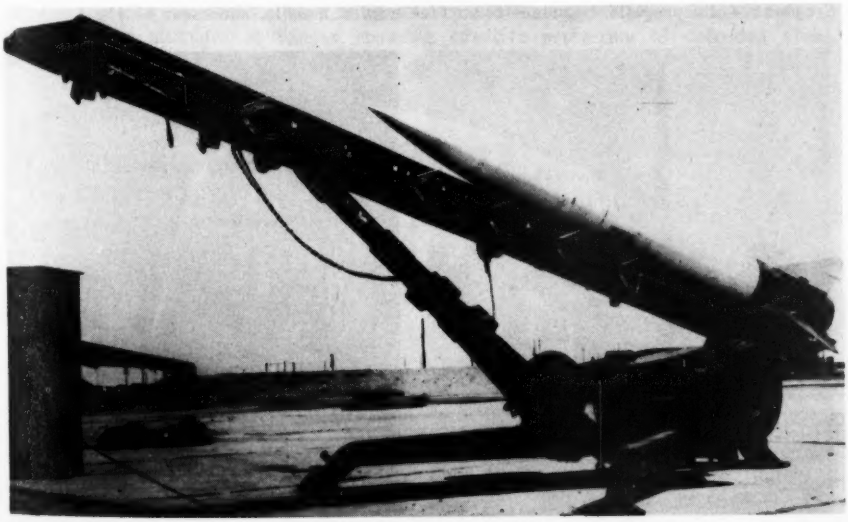
Unique *Redstone* "railroad in the sky"—test track for rockets of tomorrow

Dart antitank guided missile

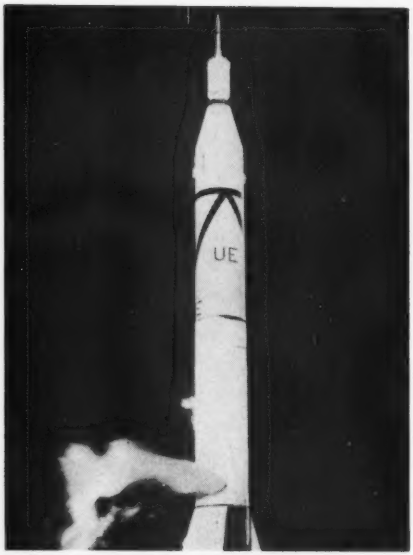


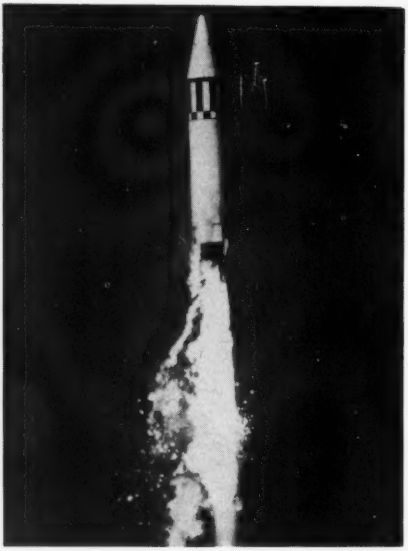
Lacrosse surface-to-surface guided missile

Honest John rocket

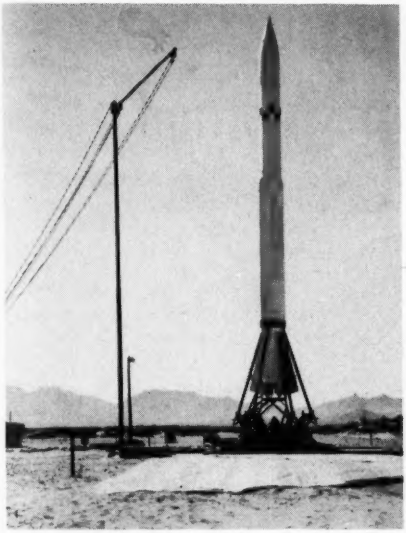


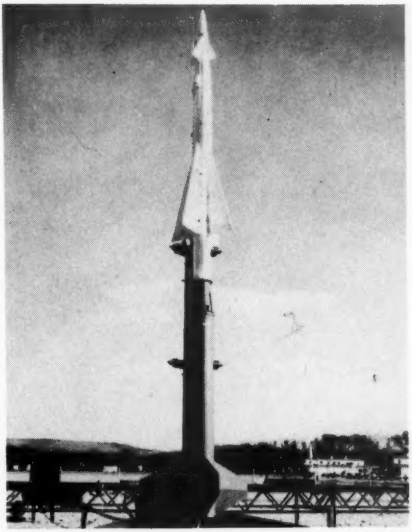
Little John



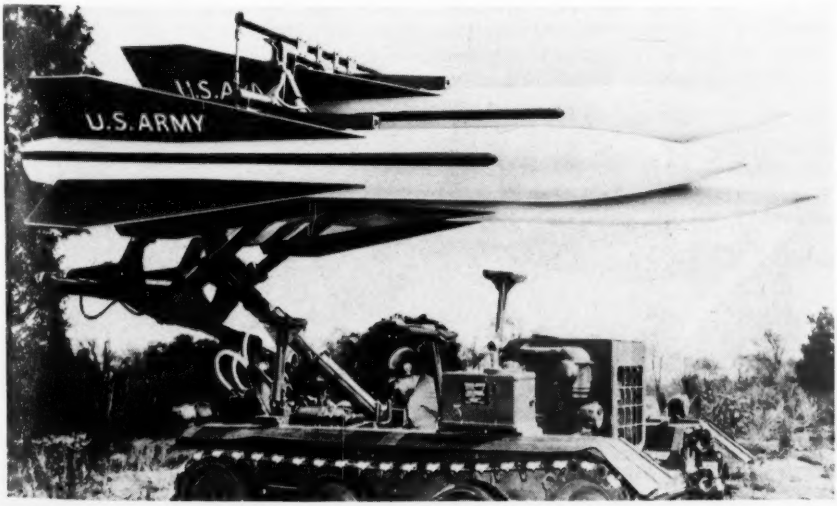


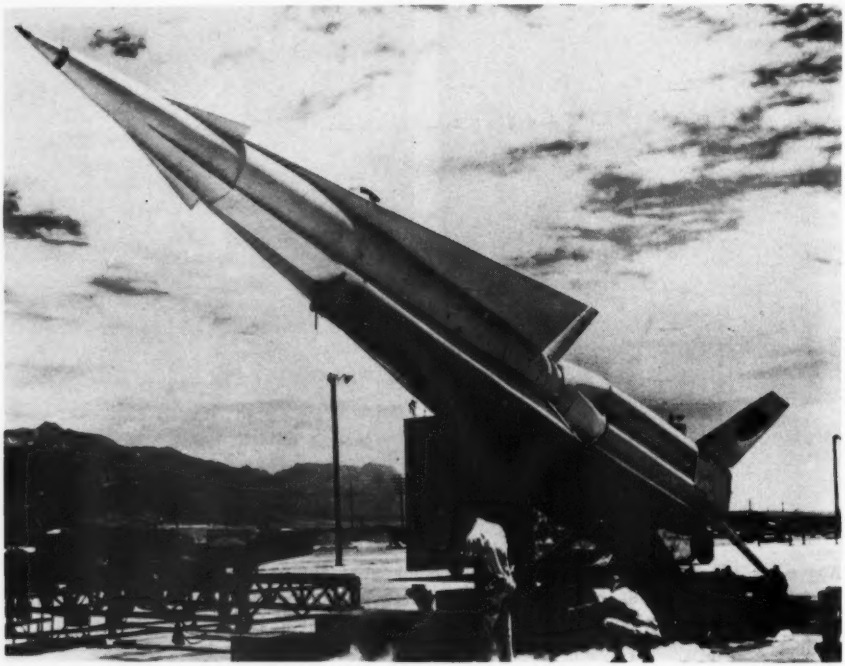
Above left, is the *Jupiter C* rocket used by the Army to launch the free world's first scientific earth satellite, the *Explorer I.* Above right, is the *Jupiter* IRBM. Below left, appears the *Redstone* surface-to-surface missile, and to the right is the *Sergeant*—solid propellant surface-to-surface guided missile, successor to the *Corporal.*





Above left, is the *Corporal* surface-to-surface guided missile. Above right, the *Nike Ajax*, the Army's first supersonic antiaircraft guided missile. Below is the *Hawk*, the Army's versatile surface-to-air guided missile which is designed for protection against low-altitude attack. This weapon is capable of destroying attackers flying at the lowest altitudes at ranges ensuring effective protection of defended areas.





The *Nike Hercules* missile, successor to *Nike Ajax*

Group of Army missiles at Redstone Arsenal

ATOMICS
Characteristics and Effects

Lieutenant Colonel Hunter L. Stockton, *Artillery*
Faculty, U. S. Army Command and General Staff College

For those who have not had the opportunity to study in the field of nuclear employment, this two-part article should provide an adequate background. The article is an excellent treatise of the basic technical aspects of nuclear employment. In this installment the author moves from an explanation of atom composition and classification to an analysis of weapons effects and protective measures to be employed.—Editor.

TO USE nuclear weapons effectively in support of ground tactical operations, a commander and his staff must be able to solve a number of problems associated with their employment. Nuclear weapons firepower is integrated into the military operation along with the maneuver of ground forces and artillery and air support. The nature and magnitude of the effects of these weapons require special attention to ensure that the impact on tactical plans is neither overestimated nor underrated.

A study of the basic physics of a nuclear weapon is centered on a minute universe so infinitesimal it is hard to imagine. Consider, as an example, a golf ball. The earth is 300 million times as large as a golf ball, and the golf ball, in turn, is 300 million times as large as an atom. If an atom is so small, how can anything be known about it? The answer is that many things can be ascertained about an atom by observing its effects. The same is true of the wind. It cannot be seen but its effects are well-known.

Atom Composition

Atoms consist of *protons*, *electrons*, and *neutrons*. All protons are identical, all electrons are identical, and all neutrons are identical; but when they are combined in various ways, they form atoms of different elements or substances. For example, one combination of protons, electrons, and neutrons forms an atom of sodium. Another combination of a different number of protons, electrons, and neutrons, combined in a different manner, forms an atom of chlorine.

Figure 1 is an atom of hydrogen, the simplest of all atoms. It consists of a negatively charged light particle called an *electron* which revolves in an orbit about a nucleus. The nucleus of a hydrogen atom is a single particle with a positive electrical charge and is called a *proton*.

The number of protons in an atomic nucleus is always equal to the number of electrons outside the nucleus.

To use nuclear weapons effectively in support of tactical ground operations requires that the commander and his staff be familiar with the basic aspects of this field in order to solve the problems that may arise

To reemphasize the submicroscopic nature of the atom, if the nucleus (proton) of the hydrogen atom could be increased to the size of a golf ball, the electron would be orbiting one mile away.

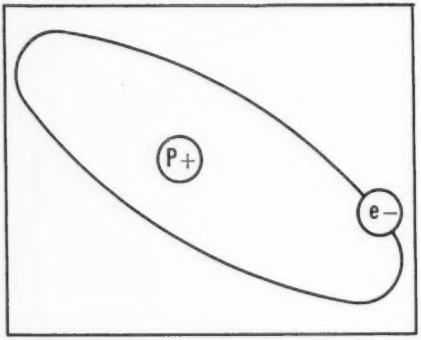


Figure 1. Atom of hydrogen

The atom of helium (Figure 2) is the next most simple atom. It contains a combination of the three kinds of particles

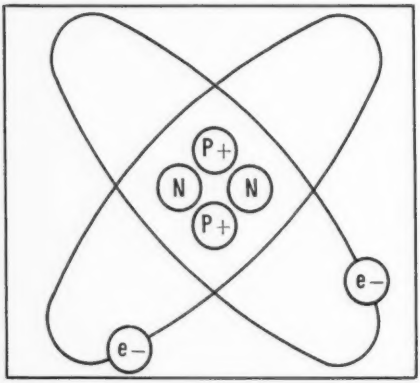


Figure 2. Atom of helium

which comprise matter—protons, electrons, and neutrons.

A helium atom has two electrons whirling around a nucleus consisting of two protons and two neutrons. A neutron carries no electrical charge and does not affect chemical behavior. Although they have no electrical charge, the neutrons exert a nuclear force which is a part of the total forces holding the nucleus together.

Classification

Scientists have classified and arranged elements according to their atomic structure. This classification is based on the *atomic number* and *atomic mass number*.

The *atomic number* refers to the number of *protons* in the nucleus. Thus hydrogen with its single proton is assigned the

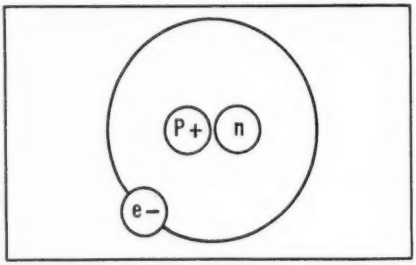


Figure 3. Hydrogen 2 atom or deuterium atom

atomic number 1. Helium is assigned the atomic number 2.

Atomic mass number refers to the number of *protons* and *neutrons* in the nucleus. The hydrogen atom depicted in Figure 1 has an atomic mass number of 1, whereas the helium atom is given the atomic mass number of 4 (two protons plus two neutrons).

To date, 92 naturally occurring elements have been discovered. Their *atomic numbers* range from 1 for hydrogen to 92 for uranium. *Atomic mass numbers* increase from 1 for hydrogen to 238 for uranium. Each element consists of atoms with varying combinations of protons, electrons, and neutrons.

As previously stated, the simplest conceivable atom is one with only one proton and one electron—the hydrogen atom. It also has been stated that neutrons carry

no electrical charge and do not materially affect the chemical behavior of an element. Thus if one neutron is added to the basic hydrogen atom (Figure 3), the electrical charge is not changed and the chemical behavior still is that of hydrogen. The only difference is that the addition of a neutron makes the second hydrogen atom heavier than the simpler atom.

The atomic number of the deuterium atom is still 1 (one proton). However, the atomic mass number is 2 (one proton and one neutron).

If a second neutron were added to the basic hydrogen atom, hydrogen 3 or tritium would result.

Chemically identical elements (that is, the number of protons in the nucleus is the same) with different numbers of neutrons are called *isotopes.*
(Example: in the hydrogen atom there are three isotopes—hydrogen 1, hydrogen 2 or deuterium, and hydrogen 3 or tritium.)

The periodic table of elements (Figure 4) shows all the elements discovered to date, plus six (93 through 98) produced artificially which do not occur in nature on this earth. Still others, not shown in the table, have been artificially produced. To the left of the chemical symbol (above the name) of each element is the atomic number indicating total number of protons in the nucleus. Under the name of each element are shown the isotopes with the total number of protons and neutrons in each nucleus. Only a few isotopes, and these are comparatively rare, are suitable at present for the production of nuclear energy.

Referring to Figure 4, it can be seen that one of the most complex atoms is uranium. It has an atomic number of 92, with five isotopic forms having atomic mass numbers of 233, 234, 235, 237, and 238.

Natural Radioactivity

Uranium and its neighboring elements are "maladjusted." Their atoms have an unstable number of protons and neutrons. Observing nature's law of balance and symmetry, these unstable atoms try to become stable by getting rid of nuclear particles. The manifestation of this nuclear instability is known as radioactivity.

Natural radioactivity is the spontaneous slow release of nuclear energy in any one of three forms:

1. Beta particles, bearing a negative charge, may be expelled from the nucleus. These particles are essentially high-speed electrons.

2. Alpha particles also may be shot out. Alpha particles consist of two protons plus two neutrons and are positively charged. These particles are the same as the nucleus of the helium atom.

3. The energy may be in the form of gamma rays, that is, electromagnetic radiations similar to X-ray.

Natural radioactivity causes these heavy unstable elements eventually to change to a stable form of lead.

The unit for measuring the rate of change or transmutation of an element is called *half-life. Half-life* is the time required for 50 percent of any given amount of radioactive material to decay.

Half-life varies from isotope to isotope. It takes 4,500,000,000 years for half of the atoms of Uranium 238 to decay to other elements. The half-life of Radium 226 is 1,600 years. That of Radon 222 is slightly less than four days.

Lieutenant Colonel Hunter L. Stockton served in the European theater during World War II. Upon graduation from the Advanced Artillery Course in 1949, he was assigned to The Artillery School at Fort Sill, Oklahoma, as an instructor until 1951. He was graduated from the US Army Command and General Staff College in 1952 following which he served in Korea with Headquarters, Eighth US Army, G3 Plans Section, and the 176th Field Artillery Battalion. He presently is assigned to the faculty at USA CGSC as a member of the Department of Nonresident Instruction.

PERIODIC TABLE OF THE ELEMENTS

	I	II	III	IV	V	VI	VII	VIII			O
I	1 H HYDROGEN 1, 2, 3										2 He HELIUM 3, 4
II	3 Li LITHIUM 6, 7, 8	4 Be BERYLLIUM 7, 9	5 B BORON 10, 11, 10	6 C CARBON 12, 13, 12	7 N NITROGEN 14, 15	8 O OXYGEN 16, 17, 18	9 F FLUORINE 19				10 Ne NEON 20, 21, 22
III	11 Na SODIUM 23	12 Mg MAGNESIUM 24, 25, 26	13 Al ALUMINUM 27	14 Si SILICON 28, 29, 30	15 P PHOSPHORUS 31	16 S SULPHUR 32, 33, 34, 36	17 Cl CHLORINE 35, 37				18 A ARGON 36, 38, 40
IV	19 K POTASSIUM 38, 39, 40, 41	20 Ca CALCIUM 40, 42, 43, 44, 46, 48	21 Sc SCANDIUM 45	22 Ti TITANIUM 46, 47, 48, 49, 50	23 V VANADIUM 51	24 Cr CHROMIUM 50, 52, 53, 54	25 Mn MANGANESE 55	26 Fe IRON 54, 56, 57, 58	27 Co COBALT (57), 59	28 Ni NICKEL 58, 60, 61, 62, 64	
	29 Cu COPPER 63, 65	30 Zn ZINC 64, 66, 67, 68, 70	31 Ga GALLIUM 69, 71	32 Ge GERMANIUM 70, 72, 73, 74, 76	33 As ARSENIC 75	34 Se SELENIUM 74, 76, 77, 78, 80, 82	35 Br BROMINE 79, 81				36 Kr KRYPTON 78, 80, 82, 83, 84, 86
V	37 Rb RUBIDIUM 85, 87	38 Sr STRONTIUM 84, 86, 87, 88	39 Y YTTRIUM 89	40 Zr ZIRCONIUM 90, 91, 92, 94, 96	41 Nb NIOBIUM 93	42 Mo MOLYBDENUM 92, 94, 95, 96, 97, 98, 100	43 Tc TECHNETIUM 96, 99, 101	44 Ru RUTHENIUM 96, 98, 99,	45 Rh RHODIUM 103	46 Pd PALLADIUM 102, 104, 105, 106, 108, 110	
	47 Ag SILVER 107, 109	48 Cd CADMIUM 106, 108, 110, 111, 112, 113, 114, 116	49 In INDIUM 113, 115	50 Sn TIN 112, 114, 115, 116, 117, 118, 119, 120, 122, 124	51 Sb ANTIMONY 121, 123	52 Te TELLURIUM (120), 122, 123, 124, 125, 126, 128, 130	53 I IODINE 127				54 Xe XENON 124, 126, 128, 129, 130, 131, 132, 134, 136
VI	55 Cs CESIUM 133	56 Ba BARIUM 130, 132, 134, 135, 136, 137, 138	RARE EARTHS See Below	72 Hf HAFNIUM 174, 176, 177, 178, 179, 180	73 Ta TANTALUM 181	74 W TUNGSTEN 180, 182, 183, 184, 186	75 Re RHENIUM 185, 187	76 Os OSMIUM 184, 186, 187, 188, 189, 190, 192	77 Ir IRIDIUM 191, 193	78 Pt PLATINUM 192, 194, 195, 196, 198	
	79 Au GOLD 197	80 Hg MERCURY 196, 198, 199, 200, 201, 202, 204	81 Tl THALLIUM 203, 205	82 Pb LEAD 204, 206, 207, 208	83 Bi BISMUTH 209	84 Po POLONIUM 210	85 As ASTATINE 211, 216, 218				86 Rn RADON 222
VII	87 Fr FRANCIUM 223	88 Ra RADIUM 226	89 Ac ACTINIUM 227	RARE EARTHS See Below							

RARE EARTHS								
	57 La LANTHANUM 139	58 Ce CERIUM 136, 138, 140, 142	59 Pr PRASEODYMIUM 141	60 Nd NEODYMIUM 142, 143, 144, 145, 146, 148, 150	61 Pm PROMETHEUM 144	62 Sm SAMARIUM 144, 147, 148, 149, 150, 152, 154	63 Eu EUROPIUM 151, 153	64 Gd GADOLINIUM 152, 154, 155, 156, 157, 158, 160
	65 Tb TERBIUM 159	66 Dy DYSPROSIUM 158, 160, 161, 162, 163, 164	67 Ho HOLMIUM 165	68 Er ERBIUM 162, 164, 166, 167, 168, 170	69 Tm THULIUM 169	70 Yb YTTERBIUM 168, 170, 171, 172, 173, 174, 176	71 Lu LUTECIUM 175, 176	

90 Th THORIUM 232	91 Pa PROTOACTINIUM 231	92 U URANIUM 233, 234, 235, 237, 238	93 Np NEPTUNIUM 238, 239	94 Pu PLUTONIUM 238, 239, 240	95 Am AMERICIUM 241	96 Cm CURIUM 241, 242	97 Bk BERKELIUM 244	98 CALIFORNIUM 244

Radioactive isotopes underlined

Additional elements have been artificially produced but are not tabulated here.

Figure 4.

Artificial Radioactivity

The radioactivity discussed thus far has been natural radioactivity. Scientists have entered this field and in some cases have outdone nature through various means of artificial radioactivity. Using as his gun, cyclotrons and other accelerators, and employing hydrogen and helium nuclei, neutrons, protons, electrons, and other minute bullets, the scientist has made stable matter unstable. He has produced radioactive isotopes of many elements. The scientist has transmuted lithium into helium with a hydrogen nucleus as the projectile. Uranium 238 has been used to create new artificial elements. A nucleus of Uranium 238 is hit with a neutron. If the neutron sticks to the nucleus, the nucleus increases its atomic weight to 239, a new artificial uranium isotope. However, this new nucleus reacts by getting rid of a negatively charged beta particle (an electron) and raises the positive charge (protron) of the nucleus by one. This results in a new element called neptunium with the atomic number 93. Neptunium is unstable and it in turn emits a beta particle and forms into another new element called plutonium with the atomic number 94.

Elements heavier than plutonium have been developed, but will not be discussed since they are not basic ingredients of a nuclear weapon.

All of the atomic particles (electrons, protons, and neutrons) have mass. When protons and neutrons are placed together in atomic nuclei, the particles *lose mass and release energy.* In other words, the parts are heavier than the whole. In certain instances a change in nuclear composition results in a loss in mass (or weight) which is converted into and released as energy. The problem of the scientist was to create and use this form of energy on a controlled basis.

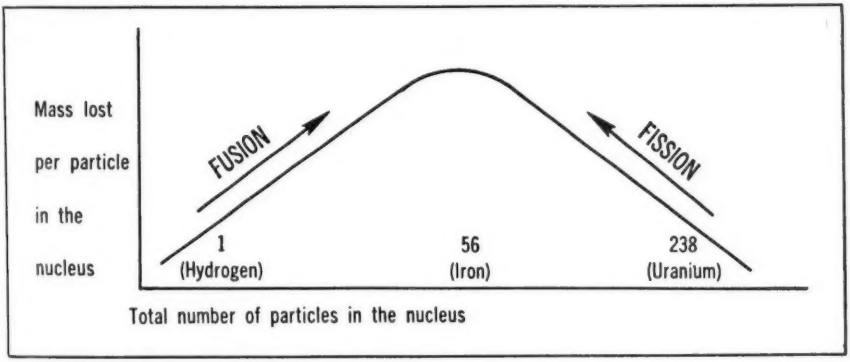


Figure 5. Nuclear stability

If the 92 elements were plotted on a chart in terms of the loss in mass (weight) per the total number of particles in the nucleus, the curve shown in Figure 5 would result.

If several light nuclei (to the left of iron) are packed together to form one nucleus, the nuclear particles will lose mass and liberate energy. This is the essence of a *fusion reaction.* If heavier nuclei (far to the right of iron) are split into two or more nuclei, the particles of these nuclei will lose mass and liberate energy. This is *fission.* There is a definite equivalence between mass and energy, and when a decrease of mass occurs in a nu-

clear reaction there is an accompanying release of a certain amount of energy related to the decrease in mass. How protons and neutrons, or nucleons, are held together in the nucleus is not known, but this mass lost as a result of the combination of the particles is considered to be the binding energy or binding force of the atomic nucleus.

Two Methods

The scientists now had two means by which to create nuclear energy; pack the lighter elements together (*nuclear fusion*), or split the heavier elements (*nuclear fission*).

While it may seem inconsistent that both the building up and breaking down of atoms release energy, this is presently possible only at the far ends of our curve of elements (Figure 5). In addition, the products of fusion and fission must tend toward a higher point on the curve and not toward a lower point.

Only two substances, at present, can be used in a fusion device; these are the two heavy isotopes of hydrogen—deuterium and tritium. Under suitable conditions, the nuclei of deuterium and tritium can be made to fuze together to form a single nucleus of helium. The neutrons and protons involved lose mass when they are packed into this heavier nucleus. This lost mass is released as energy by the fusion reaction (Figure 6). Once the reaction starts, the temperatures generated by fusion can keep the reaction going until the mass of material is blown apart.

The release of energy by the sun is an example of nuclear fusion. It continually converts hydrogen into helium and sends the resultant energy earthward. To the scientist who needed a quick solution, the duplication of conditions comparable to those on the sun seemed overly complicated. As a result, attention originally was centered on nuclear fission.

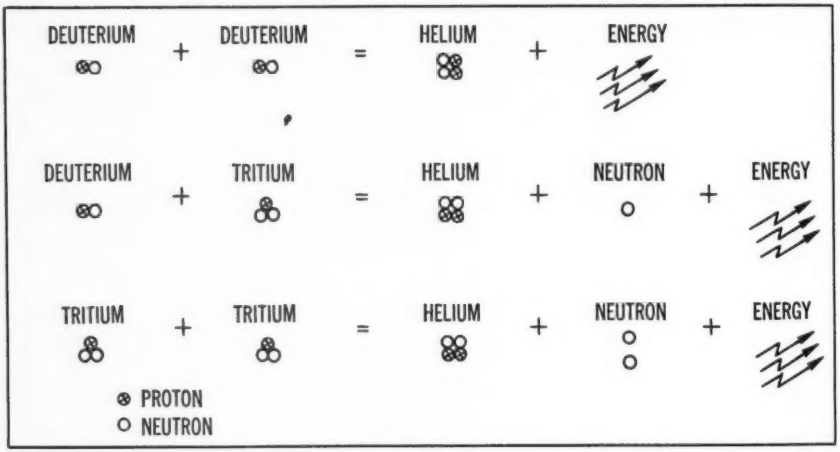

DEUTERIUM + DEUTERIUM = HELIUM + ENERGY
DEUTERIUM + TRITIUM = HELIUM + NEUTRON + ENERGY
TRITIUM + TRITIUM = HELIUM + NEUTRON + ENERGY
PROTON
NEUTRON

Figure 6. Typical fusion reactions

Only two substances exist, at present, which fission readily in a nuclear weapon to release large amounts of nuclear energy. These are Uranium 235 and plutonium. Uranium 235 comprises only a very small proportion of uranium as it exists in nature. A complex process of separat-

ing Uranium 235 from the much more prevalent Uranium 238 is required. This is called *enrichment*. The nuclear reaction for obtaining plutonium has been discussed earlier.

A fission reaction in active material (Figure 7) is started by a source of free neutrons. These free neutrons strike nuclei of active material causing the nuclei to fission. When a nucleus of active material fissions, it splits into two or three, sometimes four, new nuclei called *fission fragments*. In addition, two or three free neutrons are produced. The result of such a fission is the release of a large amount of energy. This energy, however, does not represent the full potential of a nuclear weapon. As noted in Figure 7, each fission releases additional neutrons. If these neutrons, in turn, could be used for further fissions, then a *chain reaction* would be started which could develop a tremendous release of energy.

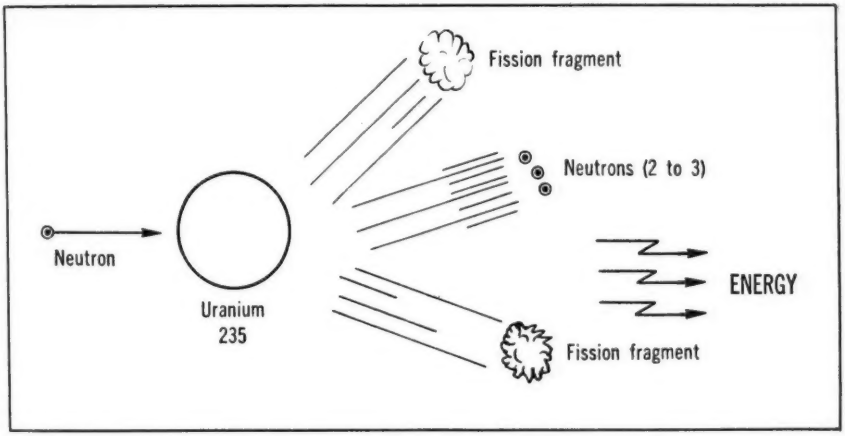


Figure 7. Fission reaction

Chain Reaction

The state of any given amount of active material can be described by the degree to which it will support a chain reaction. Returning to Figure 7, if the material is unable to capture the free neutrons, further fissions will not occur, and the reaction will be unable to sustain itself. This is referred to as a *subcritical* system or one which is unable to support a chain reaction.

If, however, one neutron created by a fission is capable of causing another fission (Figure 8), a *critical* mass is achieved. This equalizing of the birth rate and death rate of neutrons would be fine for an atomic powerplant where smooth power is required, but it would not be sufficient for an explosion.

To develop an explosion, the birth rate of neutrons must exceed the death rate. By so doing, the fission reaction is kept going in an increasing chain of fissions until the mass of active material blows itself apart with tremendous violence. Figure 9 is an example of a *supercritical* mass wherein one fission produces two, two fissions produce four, and so on. Once supercriticality is reached in a nuclear weapon, an explosion will occur. Since a nuclear weapon must be rigidly controlled, the active material is kept subcritical until the

time of explosion. When the explosion is desired, the active material is made supercritical quickly and so maintained as long as possible in order to achieve the maximum number of fissions. The time for a nuclear weapon to explode is less than a millionth of a second from the moment the subcritical parts are brought together.

A sphere was selected as the desired shape for the portion of the weapon containing the active material. Principally, a sphere affords economy of size because it has the minimum surface area through which neutrons can escape with maximum volume in which they can work. To further prevent the escape of neutrons, the sphere is coated with a special mirror which reflects neutrons.

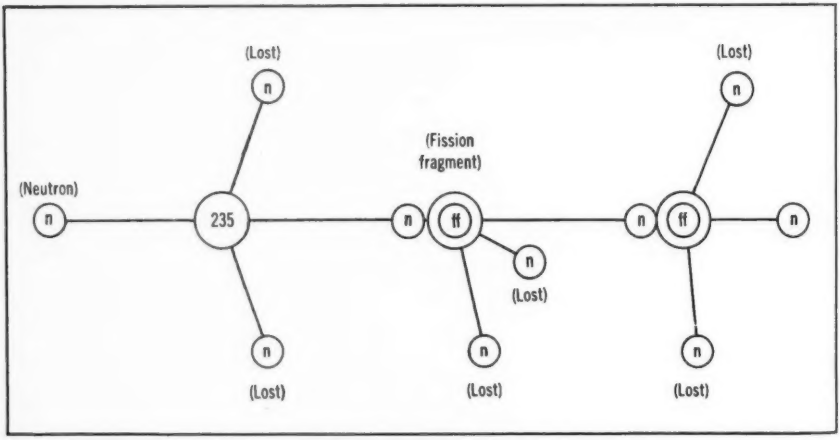


Figure 8. Chain reaction in critical mass

Detonation

With a basic understanding of the source of the energy released by nuclear weapons, the next consideration is the various types of bursts and the energy released by each.

When a high-explosive weapon goes off, the chemical energy of the explosive is converted into mechanical energy. This mechanical energy is in the form of high velocity fragments of weapon casing, and a short, sharp, blast impulse. Relatively small lethal areas result from high-explosive detonations.

When a nuclear weapon is detonated, both mechanical and radiant energy are released. The lethal intensities of the mechanical and radiant energy cover very great areas. There is no true fragmentation effect from the detonation of nuclear weapons.

The following is a sequence of events when a nuclear weapon is detonated in the air. As previously mentioned, a large ball of fire forms in a small fraction of a second. This fireball contains the energy of the explosion and is six times hotter than the surface of the sun. The size of this fireball depends on the yield of the weapon. The fireball from a nominal 20-kiloton weapon is about one-fifth of a mile across. Larger yield weapons produce larger fireballs.

Figure 10 is a photograph of a nuclear detonation in one of the air-burst test shots at the Nevada Test Site. The fireball already has started to cool and rise into

the upper air. The fireball contains radiant energy of all kinds as soon as it forms. The low frequency radiant energy is light and intense flash heat.

The light is very brilliant and can cause temporary blindness to individuals who happen to be looking in the general direction of the burst. This capability extends out several miles. Most of the heat and light come out of the fireball almost immediately—during the first second after the burst—although some continues to be emitted as long as the fireball is visible.

The flash heat radiated outward from the fireball is called *thermal radiation.* About one-third of the energy of the detonation is thermal radiation.

Nuclear Radiation

Approximately 15 percent of the energy generated by the fireball is nuclear radiation. Many different fission fragments, that is, initial fission product nuclei, are formed when uranium (or plutonium) nuclei capture neutrons and suffer fission. Most, if not all, of the approximately 80 fragments thus produced are the nuclei of radioactive forms of well-known, lighter elements. These elements usually emit beta particles and frequently, although not always, this is accompanied by gamma radiation. The rate of emission of beta particles and gamma radiation usually is expressed by means of the previously mentioned "half-life" of the particular isotope involved. The half-lives of the fission products have been found to range from a small fraction of a second to something like a million years. In addition to the beta particle and gamma ray activity there is another kind of radioactivity. This is the activity of the fissionable ma-

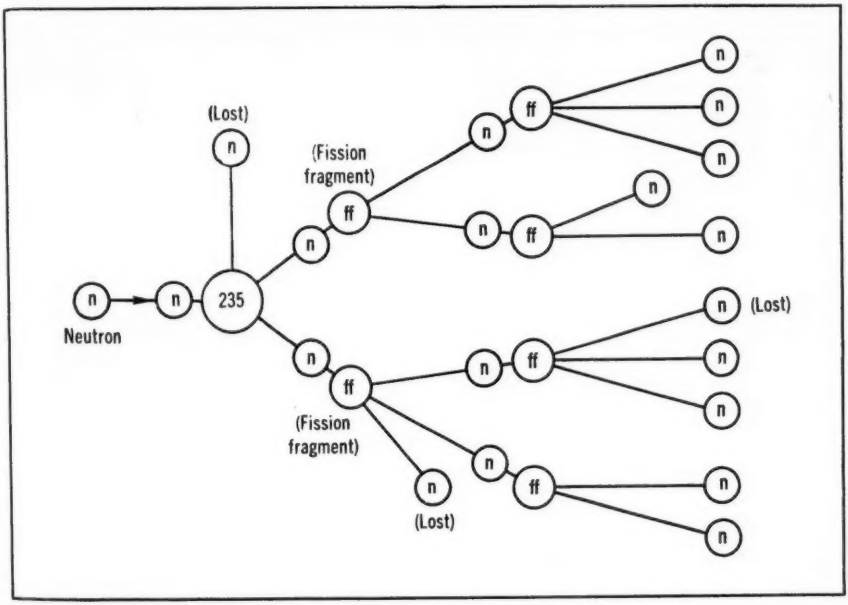


Figure 9. Chain reaction in supercritical mass

terial, part of which remains after the explosion since fission is not 100 percent complete. Both uranium and plutonium are radioactive, and their activity consists in the emission of what are called "alpha particles." In this connection it is interesting to note that Plutonium 239 has a long radioactive half-life of 24,000 years, and a biological half-life of over 100 years. The latter is defined as the time taken for the amount of a particular element in the human body to decrease to half of its initial value due to elimination by natural (biological) processes.

Figure 10. Fireball from air-burst weapon

The nuclear radiation that is emitted into the target area in about the first minute of postdetonation time is called *initial nuclear radiation.* The four nuclear products resulting from a nuclear detonation—alpha particles, beta particles, gamma radiation, and neutrons—can all ionize matter. An *ion* is simply an atom with one or two orbital electrons temporarily knocked loose from the atom. If human tissue is ionized, the chemical nature of the tissue may be changed with consequent damage to the individual.

Alpha particles are nuclei of *helium.* They are heavy particles whose penetrating power in tissues is very low. The surface layer of skin or outer clothing of an individual will stop alpha particles. However, alpha particles have great ionizing power. The only danger from radioactive matter which gives off alpha particles lies in the chance that it might be inhaled (as dust) or taken in the body with food or drink.

Beta particles have medium penetrating power and medium ionizing power. The

outer clothing of an individual keeps most beta particles from entering the body; those that enter are stopped by the first few millimeters of tissue which are not sensitive to radiation damage in any case. Beta emitting substances are dangerous only if inhaled or taken in the body with food or drink.

The ranges of alpha and beta particles are comparatively short and they cannot reach the surface of the earth from an air burst. Even when the ball of fire touches the ground, the alpha and beta particles are relatively unimportant. The initial nuclear radiation thus may be regarded as consisting only of the gamma rays and neutrons produced during a period one minute after the nuclear explosion. Both of these nuclear radiations, although different in character, can penetrate considerable distances through the air. Further, both gamma rays and neutrons can produce harmful effects in living organisms. It is the highly injurious nature of these nuclear radiations, combined with their long ranges, that makes them such a significant aspect of nuclear explosion. Although neutrons are nuclear particles of appreciable mass, whereas gamma rays are electromagnetic waves similar to X-rays, the harmful effects of these two nuclear products on the human body are similar in character.

Air Burst

The most dangerous product of radioactive decay is the high energy of gamma radiation. Gamma radiation is not so powerful in its ionizing power as are alpha particles or beta particles, but it has a much greater range. *Gamma radiation is very penetrating* and readily reaches (and causes ionization in) the sensitive internal organs which are easily damaged. For this reason, gamma radiation and neutrons are much more dangerous to human tissue than are alpha or beta particles.

In the short time required to form the large fireball, a great volume of air is pushed outward very rapidly. This outward push on the air generates a blast wave which moves outward spherically from the fireball. In other words, the rapidly expanding fireball transmits mechanical shock energy in the form of blast to the air in which the weapon is burst.

A second or two after the burst the fireball starts to rise. It rises into the upper air quite rapidly and soon cools into a typical mushroom shaped cloud. The cloud rises tens of thousands of feet into the air where eventually it is blown away by the wind. The cloud is very radioactive since it contains fission fragments and irradiated dust and debris swept up into the stem. The cloud from an air-burst weapon usually is blown apart and dissipated by the wind after one or two hours but not always, and particularly not for high-yield weapons. The radioactive particles from the cloud eventually fall to earth, or are carried down to the earth by rain. This is called *fallout*. The fallout is practically all downwind from the burst. From an air-burst weapon, particularly when the ball of fire is well above the earth's surface, essentially all the weapon residue in the form of very small particles will have risen to such a height with the fireball that the nuclear radiations no longer reach the earth in significant amounts. This residue will be carried away by high altitude winds and by the time it reaches the ground it will have decayed so that the radioactivity is not militarily significant.

Surface Burst

Next to be considered is a nuclear detonation wherein the weapon is burst on the surface of the ground. In other words, ground zero is also the burst point. The spot on the ground directly under an air burst or over a subsurface burst is also ground zero (GZ).

The energy released by the weapon is

still about one-half mechanical energy, one-third thermal energy, or heat, and the remainder is nuclear radiation. However, the surface of the ground changes these effects somewhat, and changes the results which these weapon effects produce on a target.

When a nuclear weapon bursts on the ground, the fireball forms and expands rapidly. The upper portion of the fireball transfers its energy to the air as blast, heat, and nuclear radiation. But the bottom part of the fireball which is in contact with the surface transmits its mechanical energy, heat, and nuclear radiation to the ground.

Figures 12 and 13 are sequence photographs of a land surface burst taken soon after detonation. Note in Figure 12 that the fireball has started to rise. It will soon cool and form the typical mushroom shaped cloud. Figure 13 shows that the stem of the mushroom is starting to form.

The pattern of smoke trails visible behind the burst in Figures 12 and 13 is not characteristic of a nuclear explosion. These smoke trails resulted from the release of smoke rockets at the time of burst and were used in the instrumentation program conducted by the Atomic Energy Commission.

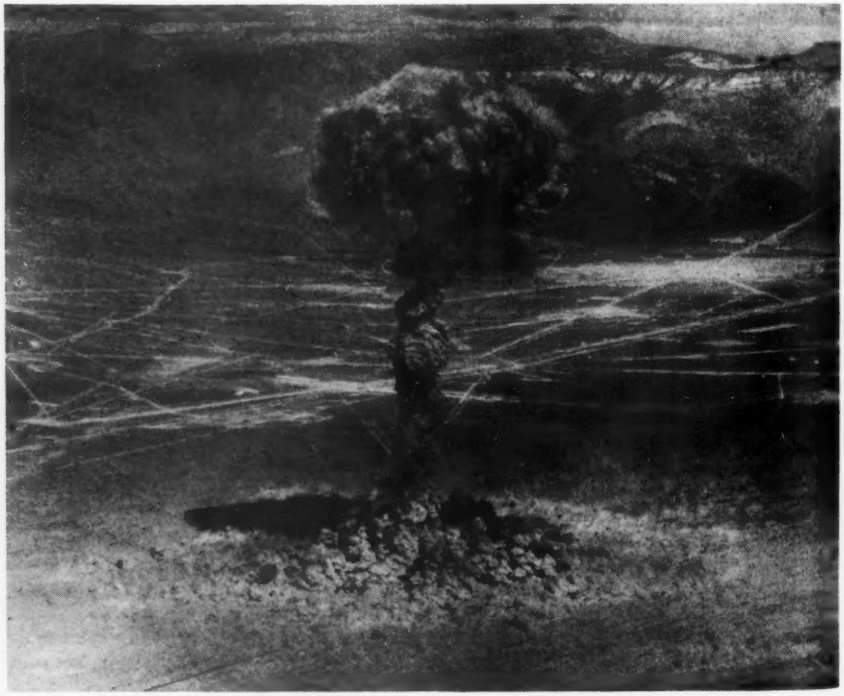


Figure 11. Mushroom shaped cloud and stem from air-burst weapon, a sequence of the photograph shown in Figure 10

Since some of the fireball expands above

the surface into the air, air blast, thermal radiation, and initial nuclear radiation go outward through the air into the target area.

Some of the fireball energy which is transmitted into the ground vaporizes a large amount of the surface of the earth under the fireball. The initial nuclear radiation makes this material very radioactive. Then the expanding fireball scoops out this vaporized and radioactive earth and blows it upward and outward from the burst point. Note in Figures 12 and 13 some of this surface material being blown outward. The burst leaves a large saucer shaped hole in the ground, called a *crater*. The vaporized earth drawn up into the fireball will condense when the fireball cools, and fall to earth downwind, producing residual radioactivity in the area of fallout. The fallout is highly radioactive and the areas covered are large. Individuals in an area of several square miles may receive a killing dose of radioactivity in an hour or two. In a few days the radioactivity decays or dies down to safe levels in most of the area except in and very near the crater.

Some indication of the rate at which the fission product radioactivity decreases with time may be obtained from the following approximate rule: For every sevenfold increase in time after the explosion, the activity decreases by a factor of 10. For example, if the radiation intensity at one hour after the explosion is taken as a reference point, then at seven hours after the explosion the intensity will have

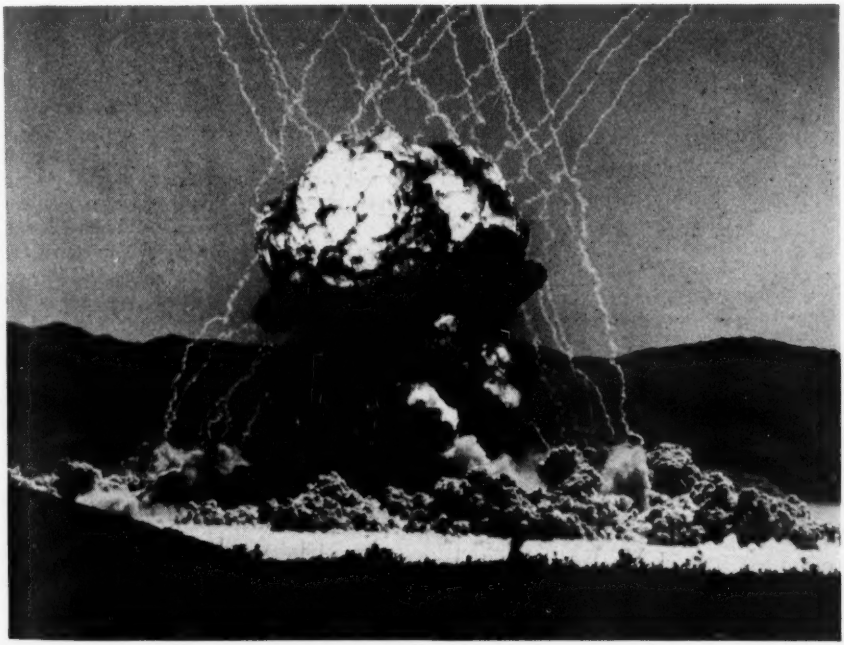


Figure 12. Fireball from surface burst weapon

decreased to 1/10; at 7 x 7 = 49 hours (or roughly two days) it will be 1/100; and at 7 x 7 x 7 = 343 hours (or roughly two weeks) the activity will be 1/1,000 of that at one hour after the burst. This rule is roughly applicable for about 200 days, after which time the radiation intensity decreases at a more rapid rate.

The fireball and cloud formed from a surface burst rises just as high as from

Figure 13. Mushroom shaped cloud and stem from surface burst weapon

an air burst. The stem is thicker and heavier and, of course, contains much more radioactive material.

Underground Burst

Figures 14, 15, and 16 are a sequence series of photographs of an underground burst. If the burst is not too deep in the ground, a small, weak fireball may be visible such as that shown in Figure 14. In deeper bursts, no brilliant fireball appears. However, the fireball does vent the surface in a relatively cool state.

Practically all of the heat and light are trapped by the ground in an underground burst. Much of the initial nuclear radiation is also trapped by the ground. Some air blast is generated by the cooled off fireball after it vents upward out of the ground. However, most of the mechanical energy of the expanding fireball pushes against the ground producing a ground shock very much like a small earthquake. Figure 15 is an illustration of how the earth above and around the fireball is blown upward and outward. This earth is intensely radioactive since it has trapped most of the initial nuclear radiation from the burst. As can be seen in Figure 16, the blown-out earth falls back; some falls back around the crater to form a lip around it. Some of the earth blown upward drifts downwind to cover a large area around the target with very intense radioactivity. The areas covered are quite large and the radioactivity so intense that individuals in an area of several square miles may receive fatal doses in a few hours. Except in and right around the crater, the radioactivity dies down to safe levels in a few days.

The cloud from an underground burst does not rise so high as that for a surface or air burst. There may or may not be a stem, dependent upon such factors as depth of burst, atmospheric conditions, and size of weapon.

The differences between air, surface, and underground bursts are shown in Figure 17.

Note that for the air burst there is no crater. However, the initial nuclear radiation may irradiate the target surface, thus inducing residual radioactivity in a small area around ground zero (neutron induced gamma activity). The initial nuclear radiation which comes out from the fireball onto the surface is all over in about two seconds. Most of the light and heat is transmitted in the first second.

Note in the surface burst that the fire-

ball gives some of its heat and gamma radiation to the surface. The fireball scoops out a saucer like crater. The dirt from the crater is radioactive material which falls out in the target area. There still is just about as much total blast effect from a surface burst as from an air burst.

In the underground burst all the heat and most of the initial nuclear radiation is trapped by the ground. The ground is then blown upward and outward. Some falls back to form the crater lip but much of it is scattered around the target area as residual radioactivity (fallout). (Residual nuclear radiation is defined as that emitted after one minute from the instant of a nuclear explosion.) There is some, but not much, air blast from an underground burst.

Figure 14. Fireball from underground burst weapon

Weapons Effects

Weapons effects are mechanical shock or blast, thermal radiation or heat, and nuclear radiation. The discussion of these primary effects will be mainly from the point of view of what they can do to a target.

First, consider what one would expect to find in a target area. Generally, the elements of a target consist of personnel, equipment, and structures. The heat or thermal radiation from a nuclear detonation is a brief, but very intense, pulse of heat. This can cause severe burns to personnel, rendering them noneffective. Thermal radiation generally does not affect equipment or structures—fabrics may char, rubber may be ignited, wood may be scorched. If conditions are right, local fires may continue to burn.

The blast wave is effective in damaging material or structures. Equipment is damaged by being blown apart or blown around; structures collapse.

Nuclear radiation does not affect equipment or structures, but can incapacitate personnel if the amount (dose) of the radiation is high enough.

It can be seen, then, that the elements of a target are not responsive to all three of the primary effects of a weapon. In the tactical employment of nuclear weapons, an analysis of the target must be made to determine which of the effects is most productive of casualties and/or damage and what intensity of this effect is needed to accomplish the required damage. With this information the use of the weapon is so planned that the effective intensity of blast, heat, or nuclear radiation covers the greatest area of the target.

As these three primary weapon effects are discussed in detail, it will be noted that several factors increase or decrease the area covered by a given intensity of heat, blast, or gamma radiation.

Practically all the mechanical energy of the expanding fireball from an air-burst nuclear weapon is coupled to the air as air blast. In a surface burst most of the mechanical energy is still air blast but some appears as a ground shock; and, of course, a crater is produced. In an underground burst there is much less air blast. Most of the mechanical energy is coupled to the ground to produce ground shock and a large, deep crater. Ground shock and cratering are effective against special targets only. These include underground structures, harbors, certain airfields (where it is more advantageous to crack and crater the runways rather than destroy

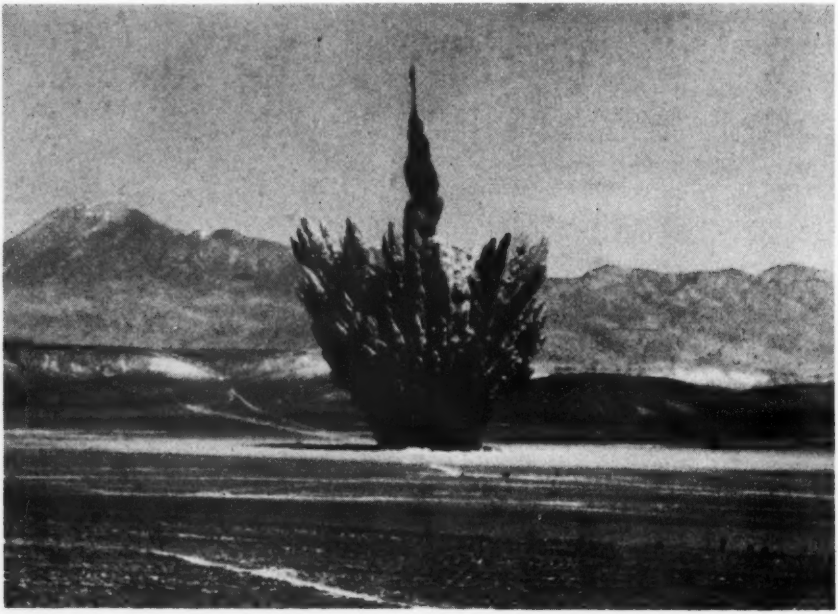


Figure 15. Blown-out earth from underground burst weapon

aboveground facilities), and occasionally defiles which it is desirable to block. *Against most tactical targets, however, air or surface bursts will be used.*

Blast Wave

As the fireball expands the air molecules are pushed outward at a high rate of speed. This expansion is so terrific that they are compressed into a blast wave which moves out in all directions from the burst. This blast wave moves at the speed of sound, approximately 400 meters per second. As the blast wave moves away from the burst, it causes overpressures; that is, pressure in excess of the atmospheric pressure of 14.7 pounds per square inch at standard sea level conditions. The main characteristic of this wave is that the pressure is highest at the moving front and falls off into the interior region of the explosion. The blast wave contains two forces that contribute to damage: static pressures which are squeezing or crushing forces and dynamic pressures which are horizontal pushing, tumbling, or tearing forces similar to winds.

Consider what happens as the blast wave travels past a target element. The traveling pressure wave hits the building like a sudden, sharp, but very high wind, and engulfs the structure in high pressure, called overpressure. As the wave moves along the static pressure slowly decreases until it has returned to normal. The pressure continues to decrease below normal atmospheric pressure and finally returns to normal. The time during which the static pressure is above normal is called the positive or pressure phase. The time

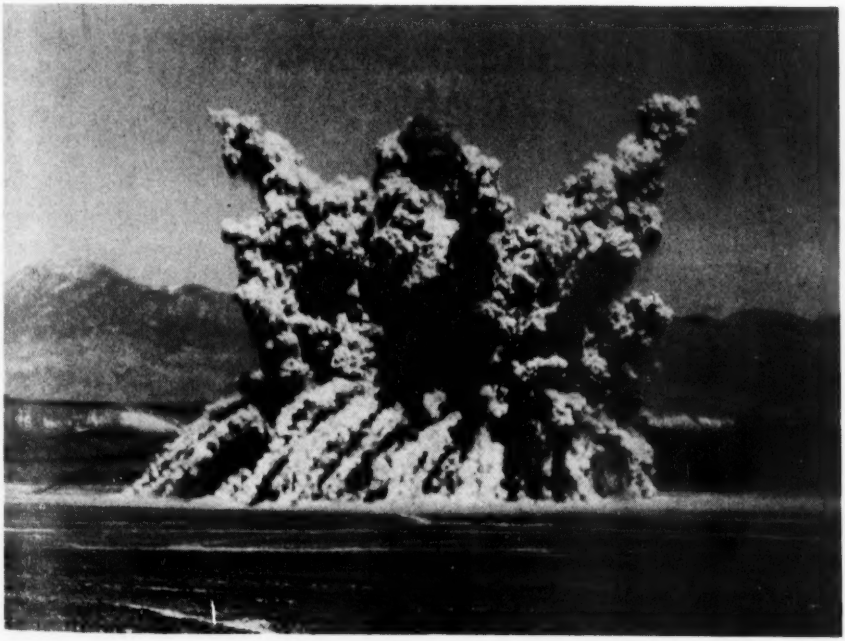


Figure 16. Fallout from underground burst weapon

it is below normal is called the negative or suction phase. Both phases contribute in damaging the structure. However, it is the highest static pressure in the positive phase that causes the most damage. The movement of the entire blast wave itself (wind effect) is called the dynamic pressure. The dynamic pressure of the blast wave causes damage by lateral displacement or tumbling of the target elements.

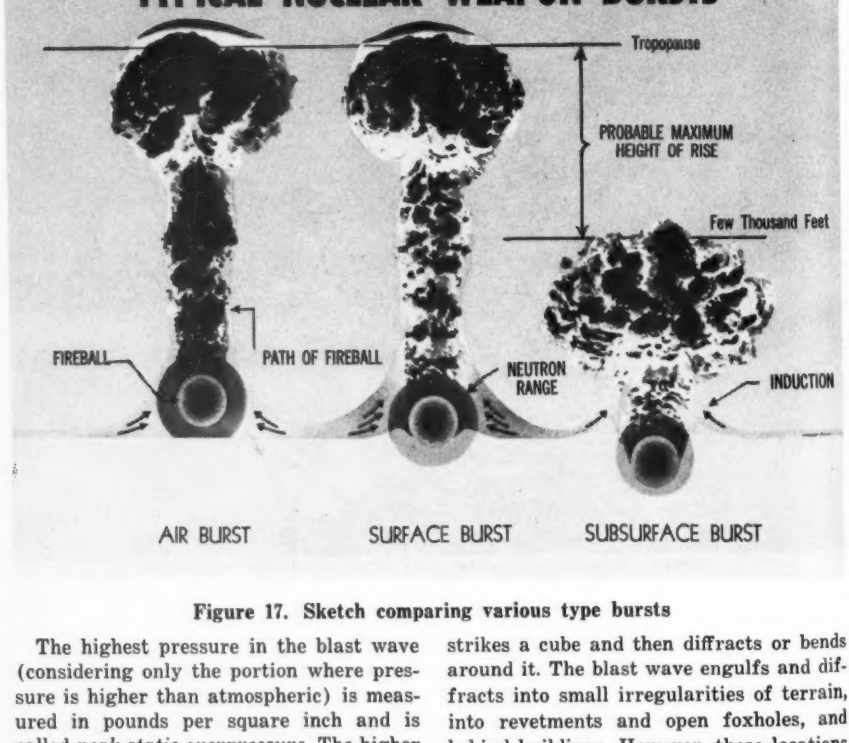


Figure 17. Sketch comparing various type bursts

The highest pressure in the blast wave (considering only the portion where pressure is higher than atmospheric) is measured in pounds per square inch and is called *peak static overpressure*. The higher the peak overpressure, the more severe is the damage done by the blast wave.

Peak overpressures near the fireball are over a hundred pounds per square inch but rapidly drop off to much lower pressures as the blast wave travels along the ground outward away from ground zero.

Movable equipment, such as vehicles, is damaged not so much by crushing as by being blown and tumbled by the blast wave.

Blast is not a line-of-sight phenomenon. Figures 18, 19, and 20 show in sequence a general idea of how the blast wave strikes a cube and then diffracts or bends around it. The blast wave engulfs and diffracts into small irregularities of terrain, into revetments and open foxholes, and behind buildings. However, these locations offer some protection from secondary blast effects (flying debris). Large steep hills offer some protection from blast on the far side. However, blast intensities are

magnified within the valleys between hills.

It was stated earlier that, in general, the higher the peak overpressure in the blast wave, the greater is the damage to a given target element. It was also pointed out that peak overpressure decreases as the distance becomes greater from ground zero. In addition, it can be stated that different structures will require different peak overpressures to cause severe damage. For example, a wooden home is more easily crushed than a steel and concrete railroad terminal. Trucks are easier to damage than tanks.

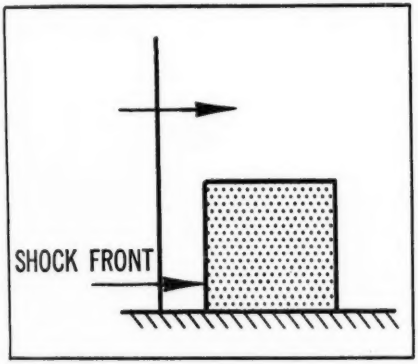


Figure 18. Blast wave approaching cube rigidly attached to ground

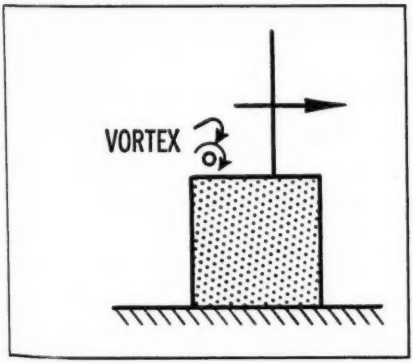


Figure 19. Blast wave moving over sides and top of cube

Moreover, even the same types of target elements do not all respond uniformly to blast. For example, two identical trucks may be parked close together near an artillery position. One may be severely damaged by a given overpressure, yet the other may be relatively undamaged due to slight variations in either the target or the blast wave. There are statistical variations in response to weapon effects even for identical target elements.

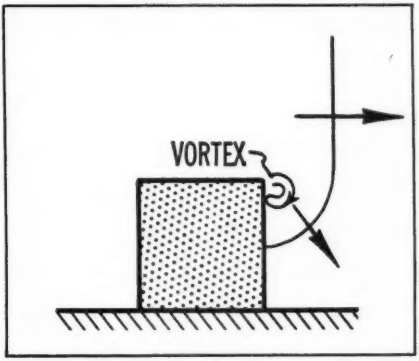


Figure 20. Blast wave moving down rear of cube

What can the blast wave do to personnel in the target area? The pressure of the blast wave (except very close to the fireball) is not high enough to give primary blast injuries to personnel except to burst their eardrums. The blast wave, however, can pick up people and throw them about as much as 20 to 30 feet and cause secondary blast injuries. The blast wave from a Nagasaki type weapon (about 20-kiloton yield), one and one-half miles from ground zero, has the effect of a 200-mile-an-hour wind. Second, the wave can pick up loose objects on the battlefield. These may include fuel cans, rifles, helmets, and even small stones. These become missiles, and if they strike a soldier, he may become a casualty.

In using nuclear weapons tactically, consideration must be given to the wind and missile effect of blast on our own personnel from a troop safety point of view. A good deal of protection from blast can be obtained by getting into a foxhole or trench, or even by lying flat on the ground. The brilliant flash from the detonation is a very good warning that a nuclear weapon has burst in the area. Since the blast wave travels only about 400 meters per second, a soldier far enough away and not immediately incapacitated by thermal radiation or gamma radiation has three or more seconds in which to take cover and thereby escape severe injury from the blast wave.

Personnel in cities are very vulnerable to blast damage. The blast wave collapses buildings. Occupants and people in the streets near buildings are killed or injured by falling debris and flying objects, particularly particles of glass.

Thermal Radiation

Next to be discussed is the flash of intense heat of thermal radiation from a nuclear detonation. Generally, only personnel in the immediate target area are affected by this flash of heat. Fabrics such as tentage may be charred, rubber tires may be ignited, and wood and some plastic objects may be scorched.

Occasionally, in cities or built-up areas, trash fires started by thermal radiation will continue to burn. Or, as happened in Hiroshima and Nagasaki, broken gas pipes and electrical short circuits (caused by blast) can start very destructive fires; but this is unlikely to happen on the battlefield.

The intense heat from a nuclear detonation is accompanied by a brilliant flash of light. Both come out of the fireball instantaneously.

In daylight, at a distance of several miles, the flash can cause temporary blindness for periods of from five to 15 minutes if a person is unwarned and facing generally toward the ground zero. The flash heat released in the first instant of detonation can burn exposed skin, char or ignite clothing, and, if the person is fairly close to the burst, produce skin burns through the clothing.

The flash heat and light from a nuclear detonation is radiated outward from the fireball in all directions. However, this heat and light has a line-of-sight characteristic. If a man is shaded from the fireball by an intervening object, he will not be burned. For example, a soldier standing

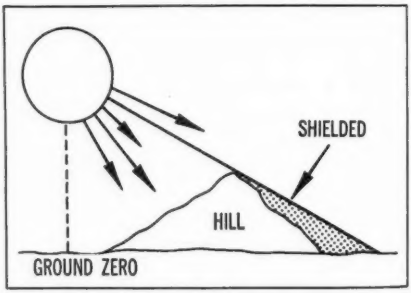


Figure 21. Thermal shielding

in back of a truck when a weapon is detonated will be shielded from the heat of the detonation and the man will not be burned. The soldier eventually may die from nuclear radiation, or the blast wave may blow the truck over on him, but he will not be burned.

Protection from thermal radiation is referred to as *shielding*. In the example above the soldier was shielded from *thermal* radiation by the truck. Trenches, foxholes—especially covered foxholes—underground shelters, and large items of military equipment such as trucks and tanks provide shielding on the battlefield.

The terrain and topography of the target area influence the effectiveness of thermal radiation. Steep, high hills or ridges can shield large areas of the target from thermal radiation if the ground zero is not carefully chosen.

Note on Figure 21 how the thermal radiation is blocked by the hill. The reverse slope of the hill and considerable area behind the hill are shielded from thermal radiation. On a smaller scale, ravines, gullies, ditches, draws, large rocks, and little ridges also provide shielding. Although the area shielded by each little gully or draw may be small by itself, the total shielded area in badly cut-up terrain may be quite large.

Similarly, personnel in wooded areas are protected from thermal radiation. The amount of protection depends on how dense the woods are, whether or not the trees have leaves on them, and on the relative position of the woods and the burst. If the weapons were burst over the woods, much of the thermal radiation would penetrate between the trees. If the woods were some distance from ground zero, the rays of heat would hit the woods at an angle and the shielding would be more effective.

It should not be concluded that woods offer good protection from the effects of nuclear weapons. There are some other factors to consider. First, if the woods are very dry, forest fires can be started very easily over a very large area by even low intensities of thermal radiation. Second, woods are not very effective in shielding from nuclear radiation. Third, the blast wave may blow down trees or large limbs and cause secondary blast casualties.

Thus far the discussion has described the influence of terrain on thermal radiation. How does the weather affect thermal radiation? Fog, rain, and snow *while they are falling* absorb much of the heat emitted from a nuclear detonation. When it is snowing or raining, the effectiveness of thermal radiation can be cut down to less than one-fourth of what it would be on a clear day. Similar conditions can be created artificially for the protection of our own troops. A smoke blanket over an area will cut down most of the thermal radiation from a nuclear weapon and provide considerable protection to friendly troops.

A dense smoke screen between the point of burst and a given target can reduce the thermal radiation energy to as little as one-tenth of the amount that would be received otherwise.

Moreover, when it is snowing, and especially while it is raining, personnel are very likely to be under some kind of shelter or cover which provides almost complete protection from thermal effects. In addition, wet clothing is almost complete protection against burns. Wet cloth will not even be scorched, although the same clothes, when dry, will char and allow the skin underneath to be burned.

The more troops are protected from heat, the higher the thermal intensities needed to cause casualty producing burns. This means that the more troops are protected from burning, the smaller is the thermal damage radius of a weapon.

Nuclear Radiation

The initial nuclear radiation produced by a nuclear explosion includes alpha and beta particles, gamma rays, and neutrons. Gamma rays and neutrons have longer ranges and are more penetrating, consequently they reach the more easily damaged internal organs of the body. Of the two, gamma rays cause casualties at the greatest distance. The initial nuclear radiation from a nuclear detonation is effective against the personnel of a target, particularly from the detonation of small-yield weapons.

As stated earlier, if a nuclear weapon is burst in the air, most of the initial nuclear radiation is released from the fireball into the target area in the first two seconds. Thus there is relatively little chance for a soldier to take any passive defensive measures against initial radiation after the burst. An air burst also produces neutron induced nuclear radiation which results in residual radiation close to ground zero. In the field the effect

of this residual radiation must be evaluated when entry into the target area is contemplated.

Some passive defensive measures have proved to be useful against nuclear radiation. If target analysis indicates these measures have been adopted by the enemy, then this factor must be considered in planning the nuclear attack.

Fallout

Residual radiation may be neutron induced gamma activity, downwind fallout, or a combination of both. Blast, heat, and initial nuclear radiation are over in approximately a minute, and with a high-yield weapon are of a casualty producing significance to a distance of about five miles from ground zero. Neutron induced radiation although significant is localized around ground zero, but fallout is a hazard that may extend over much larger areas. Fallout results from high-yield surface burst atomic weapons. A surface burst occurs when any part of the fireball touches the earth's surface.

Fallout is produced by material from the earth being taken up into the fireball, vaporized, fused with radioactive material, and then solidified to comprise the familiar mushroom cloud. The amount of matter from the ground which is contaminated by the burst and carried aloft is determined by the area of ground contacted by the fireball. The cloud may rise to 100,000 feet depending on the yield. The particles are carried downwind until they settle on the earth's surface. The time of beginning of fallout will range from immediately after the burst until 10 to 12 hours later and it will be deposited on an area over a period of one to 12 hours. The intensity of fallout and the area covered depend on the following factors:

1. Energy yield and type of weapon.
2. Height of burst.
3. Velocity and direction of wind at all altitudes up to top of cloud.
4. The composition of the surface on which the atomic weapon is detonated.

It should be remembered that radioactive material decays from the time it is produced. It also should be remembered that the rate of decay of the material resulting from a nuclear burst is greatest in the early period after the burst. Therefore, the radiation dose rate is highest when fallout begins but it also decreases most rapidly at that time.

The fallout will be estimated by appropriate staff officers based upon the best information available. A simple wind plot vector diagram based on measured winds between the surface and the top of the cloud can be used to estimate the area where fallout is possible after any size burst. This information normally is available at army, corps, and division headquarters.

Radiation Effects

There are three casualty-producing effects of radiation: superficial skin burns caused by nonpenetrating residual beta radiation, internal injury from breathing or ingestion of radioactive material, and damage to inner tissues by penetrating radiation. Simple countermeasures such as shaking, brushing, or washing radioactive material from clothing and skin can prevent skin burns if accomplished without delay. Test data indicate that inhalation of radioactive material is negligible during and after fallout contamination, but that ingestion may be a significant hazard. Measures are, therefore, required to ensure that contaminated food and water are not used and that containers of food and water are decontaminated properly before being opened. *Damage to inner tissues caused by penetrating radiation is the primary hazard from both initial and residual radiation.*

The earliest and most obvious consequence of radiation exposure is vomiting. In general, it may be assumed that those who do not vomit on the first day have not

received a serious dose of radiation. No specific first aid exists for radiation sickness. Medical personnel will direct the care and evacuation of radiation casualties, depending on the severity as in any other type of sickness. After initial symptoms of vomiting subside there is a period of time before the other symptoms appear. This period varies from three weeks for lower doses to several hours for doses of 600 roentgens (r). During this period the individual is capable of carrying out his duties, if necessary; but plans should be made for evacuation and replacement.

The casualty-producing potential of radioactive fallout is based upon:

1. Time of arrival of fallout.
2. Dose rate at that time.
3. Degree of shielding of personnel in the area.
4. Time spent in the area after fallout.
5. Decay rate of radioactive material.

Protective Measures

Protective measures for individuals are necessary. All units of platoon size and larger will be equipped with gamma radiation monitoring instruments which measure the total dose received. These instruments will provide the information required to determine when and where protection is required and the effectiveness of protective measures. The greatest potential danger from fallout can be avoided by proper protection of personnel during the early hours following the arrival of fallout. The best form of protection in the field is a covered foxhole or other underground fortification. Open foxholes will reduce the residual radiation dose to about one-tenth that received by personnel in the open. Minor modifications will increase the protection.

Personnel in medium tanks will receive only a fraction of the dose from residual radiation compared to those in the open. It will be necessary for personnel in some areas to stay in their shelters for extended periods of time. However, it is recognized that the time or materials required to construct elaborate shelters often are not available in the field. Therefore, the most practicable solution is modification to existing shelters to provide an added degree of protection.

The following protective actions should be taken (when consistent with the mission):

1. Dig foxholes or other underground shelters for all personnel at all times and improve them as time permits.
2. When a warning is received or instruments indicate the beginning of fallout, all personnel immediately enter and cover foxholes with poncho, shelter half, or other cover. This type cover does not reduce the radiation but it prevents radioactive material from entering the foxhole and can be thrown out when fallout stops.
3. Report the beginning and intensity of fallout to the next higher headquarters.
4. Keep under cover until fallout stops.
5. When fallout stops, stay in foxhole and brush the dust from clothing and scrape up and throw away anything that falls into the hole. Dig deeper and pile the earth on the edges of the hole.
6. If it is necessary to cross a radioactive area, cross it fast, in vehicles if possible. If it is necessary to enter and remain in a radioactive area, go in fast, dig fast, and keep down as much as the situation permits.

There are several command and staff problems resulting from large area fallout. It is necessary to minimize casualties and also to carry out the mission of the unit concerned. Casualties can be reduced by protection and/or by movement out of the heavily contaminated area and replacement of exposed units before critical total dose is received. Reports to the next higher headquarters on the beginning and intensity of fallout are necessary in order that the over-all situation and appropriate action can be determined. (To be continued.)

The Estimate and the Duke of Wellington

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THE estimate of the situation is not totally accepted by military men as the best way to arrive at a decision. As in all things, there are critics, false prophets, and downright disbelievers. It is, of course, possible to cite examples of great captains of the past who, apparently, made snap decisions on the field with remarkable success. One such instance is concerned with the actions of the Duke of Wellington at Waterloo. Proponents of the "generalship through instinct" philosophy often quote the following anecdote in support of their theory.

The Earl of Uxbridge commanded all the duke's cavalry, and had the duke fallen, the Earl would have succeeded to command by virtue of seniority. Being naturally anxious as to the plan he might have to carry out, he obtained an interview on 17 June, after the battle of Quatre Bras and just prior to the decisive battle on the following day. His query was met by a question from the duke, "Who would attack, I or Bonaparte?" "Bonaparte," was the answer. "Well," said the duke, "Bonaparte has not given me any idea of his projects, and as my plans will depend upon his, how can you expect me to tell you what mine are?"

This statement has been construed by some to mean that the duke had made no estimate of the situation (or appreciation, in British parlance), did not make one, and deployed and fought his forces by decisions made on the spur of the moment. A critical examination of some of the events that transpired on that historic 18 June 1815 may shed some light on the validity of this reasoning and reveal how the duke arrived at his decisions.

Résumé of Waterloo

Napoleon, never noted for a lack of expression, made several statements both before and after the battle that have a bearing on the subject. One of his maxims was, "It is the general who makes the least number of mistakes who usually gains the victory." Still another said, "War is not a conjectural art." Specifically concerning Waterloo he charged, from exile, that:

1. The Duke of Wellington was surprised by the French advance.
2. He (the duke) fought afterward in a bad position.
3. Eventually the duke delivered a battle he should have declined.

So said the emperor.

It was common knowledge that any French attack in Belgium would have as its objective, both military and political, the capital of Brussels. Even the drummer boys had this fact in mind. There were five generally accepted avenues of approach available to the French at the time. From their dispositions and later writings it appears that the English were most concerned with the more western avenues, through Mons. However, the armies were so disposed that they could contest, and did, any general advance on any of the main routes. Another consider-

Many military experts attribute the Waterloo victory to powers of inspiration and leadership. Did the Duke of Wellington make an estimate of the situation or were his decisions made on the spur of the moment?

ation was the desire to spread the troops out in order to lessen the burden on the friendly population, upon which they depended to some degree for their subsistence. When the French did cross the border they were met by both principal allied armies—the Prussians at Ligny, and the British at Quatre Bras.

Initial Engagements

The initial engagements did not go well for the allies. The Prussians were defeated, but not broken. Marshal Ney and Wellington fought to a standstill at Quatre Bras, but this action did prevent the English from coming to the aid of their Prussian friends. The Prussians were forced to withdraw to the north in the direction of Wavre. The English then were faced with an undesirable situation. If they held the ground they had defended, Napoleon could strike their position with the bulk of his army. Wellington decided to withdraw to a line generally parallel with the march objective of the Prussians, in the vicinity of the little-known village of Waterloo.

This retrograde operation was not closely followed by the French, and the duke had considerable freedom of choice in selecting the site for his next stand. The area selected was between the villages of Mont St. Jean and La Belle Alliance. Between these villages lies an east-west valley some three miles long, of varying width but generally not exceeding half a mile. On each side of the valley there is a chain of low hills, running somewhat parallel to each other. The slopes of the hill ranges into the valley are gentle, but not uniform. The English army occupied the northern ridge, and eventually the French the southern one. The right (west) flank of the English position was protected by a ravine and a small village. The left (east) flank received similar protection from two hamlets.

In front of the English position on the right flank was a farmhouse (Hougoumont) which was garrisoned strongly. Through the center of the position ran the Charleroi-Brussels highway. Slightly to the west of this road, and forward of the position, was the village of La Haye Sainte, also garrisoned. Behind this position was the vast forest of De Soignies. This then was the "bad" position selected by Wellington for the crucial battle of his military career.

The disposition and capabilities of the Prussians must have had considerable weight in the selection of the battle area. It was with full reliance upon the promise of the Prussian commander, Blücher, that Wellington decided to stand his ground and fight at Waterloo. On the evening of the 17th the following message was received from Blücher, "I will join you with not only two corps, but with my whole army. If the enemy does not attack you on the 18th, we will attack him together on the 19th."

The Prussians were at Wavre, some 12 miles road distance to the east on the morning of the 18th. The duke accepted battle under the belief that he would be supported by the Prussians. Initial elements were expected to arrive in four hours. The fact that he held his ground and gave battle for *eight hours* unsupported indicates that the selection of terrain and disposition of his forces was more than a haphazard arrangement.

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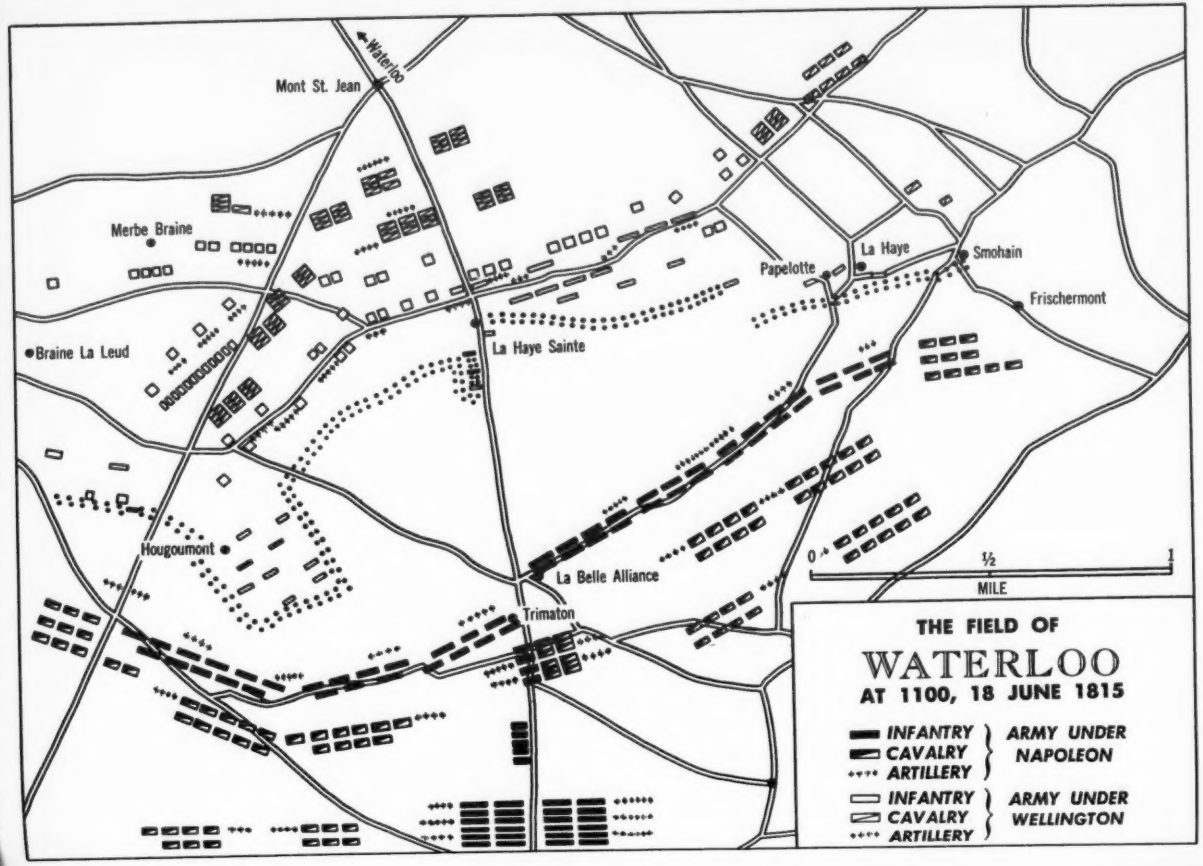

Waterloo
Mont St. Jean
Merbe Braine
Braine La Leud
La Haye Sainte
Papelotte
La Haye
Smohain
Frischermont
Hougoumont
La Belle Alliance
Trimaton
0
½
1
MILE
THE FIELD OF
WATERLOO
AT 1100, 18 JUNE 1815
INFANTRY
CAVALRY
ARTILLERY
ARMY UNDER NAPOLEON
INFANTRY
CAVALRY
ARTILLERY
ARMY UNDER WELLINGTON

The deployment of the English and allied units on the field of battle was rather unique and worthy of mention. In addition to the two outposts previously mentioned, the infantry was deployed in two lines along the ridge. The second line was composed of regiments whose fidelity was doubtful, or who had suffered severely at Quatre Bras. All was not harmonious within the ranks of Wellington's army, and there were units present that were thought to prefer the Eagles of France to the Lion of England. The infantry regiments were formed into squares. The outer ranks had bayonets fixed, the inner ranks were prepared to fire at the rapid rate, and the center of the square provided room for command and control as well as a protected area from the French cavalry.

It was under these circumstances that the Duke of Wellington waited, coolly, for Napoleon to commit his forces. The outcome, of course, is one of the better known facts of history. Never before had a French army suffered such terrible and complete defeat. The English squares would not budge from their positions, every French assault was repulsed, the Prussians arrived in time to collapse the French east flank, and at the critical moment while Napoleon and Ney were trying desperately to reorganize the Imperial Guards, Wellington seized the initiative and ordered a general advance against the shattered French forces.

Napoleon's Actions

The loser in this titanic struggle was a firm advocate of the estimate. In happier days Napoleon had stated, "If I appear to be always ready to reply to everything it is because, before undertaking anything, I have meditated for a long time—I have forseen what might happen. It is not a spirit which suddenly reveals to me what I have to say or do in a circumstance unexpected by others—it is reflexion, meditation." Also, one of the emperor's many maxims states, "A general should say to himself many times a day: If the hostile army were to make its appearance in front, on my right, or on my left, what should I do?" Is it proper to conclude that in this instance Napoleon did not "consider," "meditate," and "estimate"? Probably not.

The decision to invade Belgium and attack the allies was made as a result of the mathematical certainty that the allied forces on the Rhine would increase in numbers much faster than reinforcements could join the forces of France.

Napoleon's consideration of the forces involved took cognizance of the fact that the allied troops were under command of two generals and represented nations differing both in interest and feelings. At the same time, his own forces were exclusively French, partly veterans, well-acquainted with their officers and each other, and enthusiastically confident of their commander. His stated estimate of the relative value of the troops involved was, "A French soldier would not be equal to more than one English soldier, but he would not be afraid to meet two Dutchmen, Prussians, or soldiers of the confederation."

French Dispositions

The French dispositions on the field generally are commended by all historians of the period. The forces were arranged rather evenly across the front with the Imperial Guards, cavalry as well as infantry, in the rear of center as a reserve. The presence and location of the reserve permitted reinforcing an attack in any direction, plus the ability to resist any attack made upon the French positions. The French could have moved to envelop the allies' right (west) flank which was the capability most feared by the duke.

The night 17-18 June was marked by considerable rain throughout the battle area. The rain and mist prevailed until almost 0900 on the morning of the battle. At this time, the clouds gave away and a brisk breeze came up. Surveying the

situation, Napoleon decided to delay his attack for several hours in order to allow the ground to dry somewhat. As he relied heavily upon his cavalry and artillery it probably was a prudent move to wait until such time as they could maneuver freely on the ground.

The attack plan of Napoleon was simple and well-conceived. He had correctly analyzed the British weakness on the left, and planned an attack against the British left and center, with an earlier attack against their right in the vicinity of Hougoumont. The purpose of the attack by Reille on Hougoumont was to deceive the British and force them to commit forces away from the sector of the main attack. Had the plan succeeded it would have cut the escape route to Brussels and separated the British and Prussian forces in order that they might be defeated in detail.

Why then did these carefully considered plans fail, and end in a humiliating defeat? Many reasons have been given, but probably two are paramount. Thinking the Prussians had withdrawn to the east, Napoleon did not believe that they could join forces with Wellington, and even if they did make an appearance on the field, he expected to be supported by Grouchy. Grouchy had been detached after Ligny to pursue the Prussians and prevent their joining forces with the British. In this mission he failed completely. In addition, he reassured the Emperor that the Prussians were retreating beyond Brussels and that he was advancing from the east.

Napoleon's confidence in his marshal was so complete that he mistook the first Prussians to arrive as the advance forces of Grouchy. The second reason for failure, and probably the most important, was the French regard for the British infantry. Napoleon did not calculate on the enduring courage of these troops. The coolness with which they stood their ground transcends all eulogy. Hundreds were annihilated by artillery without having fired a shot. The 27th Regiment (now the Royal Inniskilling Fusiliers) had 400 men and every officer, except one subaltern, knocked down in their square, without moving an inch or discharging a musket.

Actions by the Duke of Wellington

There is no documentary proof that the Duke of Wellington wrote or made an estimate of the situation in order to arrive at the various decisions with which he was faced. The general staff of the time was not highly developed, and although gorgeously outfitted, they often were little more than messengers. There was no G2 or G3 present who could include in his memoirs the factors considered. The decisions themselves, however, lead to the conclusion that the Duke of Wellington was not acting on the spur of the moment, nor was he surprised or outmaneuvered.

Consider some of the duke's actions and decisions on the day of the battle for the presence of a continuing estimate—if any. The duke arose very early, and by 0300 he had written four letters—one to the Duc de Berry at Ghent to arrange for the escape of Louis XVIII, just in case; one to the British ambassador in Brussels; another to the Governor of Antwerp; and, finally, a note to Lady Frances Webster warning her to be ready to leave Brussels at a moment's notice. All these precautions on the day of the battle, and prior to daylight!

Related to the selection of the defensive position before Waterloo was the previous decision to withdraw from Quatre Bras. Certainly, a consideration of enemy capabilities effected this decision. The allies had fought furiously to maintain their position at Quatre Bras, which they did. With the Prussians withdrawing to Wavre, however, a new course of action was in order. The decision was made and orders issued for a withdrawal to a point parallel with the march objective of the

Prussian's. History upholds the wisdom of these decisions.

In addition to the dispositions of the troops at Waterloo, the duke had an additional 14,000 men a day's march to the west, guarding against an envelopment from that direction. Many historians criticize this "waste" of troops to counter a move never considered by Napoleon. However, the possibility of such a move by the French existed, and this is exactly the maneuver recommended by Reille when Napoleon asked his opinion on the morning of the 18th. The decision to so place these troops must have considered enemy capabilities and own dispositions.

Attack Well-Timed

The final decision made by Wellington to attack the shattered French columns before they could be reorganized, was superbly timed. It was at this point the duke is reputed to have said, "Up Guards, and at 'em." Later he stated that actually he probably said, "Stand up Guards," and issued the order for the attack. Regardless of the verbage, the timing was perfect. It was Napoleon who said (not about Waterloo), "The passage from the defensive to the offensive is one of the most delicate operations of war."

Many military experts attribute the victory at Waterloo primarily to Wellington's tremendous powers of inspiration and leadership. Certainly, this was a contributing factor. However, these traits would have to be balanced against that of the opponent. There is every indication that the duke was aware of his own accomplishments, and even to a greater degree he appreciated the capabilities of his opponent. He had stated that the presence of Napoleon on the field of battle was equal to 40,000 troops. Later this remark was clarified to mean a general relationship, and not, of course, the equal of a reinforcement of 40,000 troops. The duke also said of Napoleon that there never existed a general in whose presence it would have been more dangerous to make a false step. Obviously, then, Wellington must have weighed his capabilities against those of his worthy opponent.

As previously stated, those who believe the duke made his decisions by instinct base much of their case upon his remarks to the Earl of Uxbridge on the eve of the battle. Actually, this probably is another example of the sardonic irony with which the duke treated his fellow nobleman. Before Uxbridge could complain of this particular runaround Wellington added, "There is one thing certain, Uxbridge; that is, that whatever happens you and I will do our duty." Then again when Uxbridge was wounded at his side and exclaimed: "I've got it at last!" the duke merely remarked: "Have you, by God?" In all fairness to his second in command the duke wrote quite highly of him in his Waterloo Dispatch, and failed to mention an awkward position Uxbridge fell into at Genappe which required a charge by the Life Guards to rectify.

Conclusion

Perhaps the nearest evidence of an appreciation of the situation was voiced by the duke himself on the morning of 19 June in Brussels. In a conversation with the Parliamentary Mr. Creevey, long a critic of the duke, he said, "It has been a damned serious business. Blücher and I have lost 30,000 men. It has been a damned nice thing—the nearest run thing you ever saw in your life." These certainly are the remarks of a man who appreciated the situation, both before and after the fact. The duke correctly analyzed his mission, he gathered all available information, he formulated courses of action, and analyzed, compared, and arrived at sound and timely decisions.

The man who surveyed the host of Napoleon with the remark, "We will show Boney today how to defend a position" did so with the full confidence that he had correctly estimated the situation.

ADAPTED TO THE GENIUS OF A PEOPLE

Lieutenant Colonel Harry E. Ruhsam, *Artillery*
Division Artillery, 101st Airborne Division

THE late General Stilwell categorically maintained that "the Chinese soldier, properly fed, trained, equipped, and led, is the equal of any soldier in the world." He was not the first to believe this. "Chinese" Gordon, a famous British general during the latter part of the 19th century, felt the same way, and like Stilwell he proved his point leading Chinese troops on the battlefield.

Since the end of World War II the United States has been continuing to train, equip, and assist in providing better leadership for the armed forces of many nations of the world, including Free China. The results have been significantly more effective fighting forces for the defense of the nations so aided and consequently better security for the free world through mutual defense arrangements. Some of the best American talent and effort have been put into this program in Free China; the Chinese, for their part, have indicated an amazing capability for absorbing modern equipment and techniques. As a result they now have what is generally considered to be one of the finest armed forces of any nation of similar size in the world. At the same time, however, we might well give pause to consider if in fact we have used the right measuring stick—the proper criteria—in determining the present effectiveness of the Chinese armed forces. It may be that the optimum effects of our advisory efforts have been mitigated not only in Free China, but also to varying degrees in many of the other nations we have been assisting.

Approach

There appears to be an inherent shortcoming in our approach to the problem that stems basically from a failure to recognize and to take full advantage of the qualities of people who are not American. The qualifications of Stilwell and Gordon, "properly fed, trained, and equipped," and all that is inherent in them (appropriate organization, tactics, and doctrine) are not being achieved fully.

One of the reasons for this is due to our attempts to strengthen foreign armies using as a model the best fighting force we know, with its personnel, equipment, organization, doctrine, tactics, and techniques. That model is the United States Army. Perhaps we have lost sight of the fact that this Army was built of, by, and for Americans. This, of course, is as it should be. In the words of General Johnson Hagood, Chief of Staff to General Pershing in 1918, "The military system of a country must be adapted to the genius of its people." As a corollary, what is adaptable to American genius is not necessarily adaptable to the particular genius of the Chinese, or of any other people, for that matter.

Chinese Characteristics

It would be redundant here to define American genius. What, then, is the particular genius of the Chinese that makes

We must consider the strong as well as the weak points of the differing cultures of the various nations we are assisting, and, at the same time, take the maximum advantage of their inherent native qualities

him potentially a superb soldier? The answer comes from a study of Chinese history, sociology, philosophy, and of the Chinese himself. The particular genius of the Chinese is his ability *to endure*—to endure physical and mental hardship under conditions that would cause most products of western civilization to succumb.

The typical Chinese soldier is a product of a rural environment. From his earliest days he has been conditioned to the tasks which have been basic to soldiering since the beginning of time—working long hours out of doors in mud and dust, heat and cold, rain and sun; carrying heavy loads up and down hills over narrow trails; existing on a meager and simple diet; and digging, chopping, hoeing, and plowing. He is cheerful and willing because he has been reared under a philosophy that teaches such behavior as a virtue. He requires little, yet offers much. Could one ask for more in the raw material from which to mold an army?

Unfortunately, in our eagerness we have attempted to make this material over in the image and likeness of American manpower, attaching to it all the trappings considered necessary within our own military structure and by so doing perhaps are slowly impairing his once limitless native mobility—by test the finest battlefield mobility in the world.

Use Strong Points

The Chinese themselves long have understood this in its many ramifications. An old proverb says, in effect, "One who does not wear shoes has no fear of one who does." And in our time, General Sun Li-jen, who attended Virginia Military Institute, wrote an article for *The Army Combat Forces Journal*, the title of which speaks for itself, "In China, Reconnaissance Is for the Foot Soldier."

This is not to imply that we should cease in the application of our own experiences, techniques, and equipment to assist the Chinese and our other allies in building better armies. Stagnation and complacency in any organization are preludes to decadence. As a matter of fact, Dr. Sun Yat-sen, the father of the Free Chinese Republic, long ago preached that in order to progress, China must borrow of the scientific progress of the west, while at the same time retain the strong points of her own culture and civilization. This is just the point that we should consider in a searching reanalysis of our military advisory efforts abroad: *the strong as well as the weak points of the differing cultures of the various nations we are assisting.* Are we giving to our allies only the tools and ideas they need and can use effectively? Are we at the same time recognizing their inherent native qualities and other factors that will give added strength to the system, and insisting that maximum advantage be taken of them?

Conclusion

Without this careful amalgamation of "American genius" with the particular "genius" of our partners, we will continue in our time to find it difficult to match the accomplishments of Stilwell and Gordon. Upon the rapidity with which we attain success in this effort may depend the survival of what is left of the free world outside our own borders.

Lieutenant Colonel Harry E. Ruhsam entered the service in 1942 after graduation from Iowa State College. He also is a graduate of the Advanced Course, Artillery and Missiles School; the Strategic Intelligence School; the Army Language School; and the Associate Course, U. S. Army Command and General Staff College. During World War II he served in China, Burma, and India. Subsequent to the war he was a member of the Army Advisory Group, Nanking, China. After a tour with the 82d Airborne Division, he was assigned to the Airborne Service Test Division of Army Field Forces Board Number 1. From 1954 to 1957 he was Assistant Army Attaché at the US Embassy, Taipei, Taiwan. At present he is assistant executive of Division Artillery, 101st Airborne Division.

The Essentials of Military Field Experimentation

Colonel Wesley W. Yale, *United States Army, Retired*

TACTICAL dispersion required of units on the atomic battlefield will demand leadership of the highest type.

Troop leading techniques will call for a thorough knowledge of weapons capabilities and the capacity to integrate new long-range weapons with the maneuver force.

Scientifically controlled field experimentation conducted now will contribute invaluably not only to the knowledge of the future leaders, but to the state of training of Army units. The Combat Developments Experimentation Center at Fort Ord, established slightly more than a year ago, is an important link in the Army's chain of preparedness for future war.

The mission of the center is generally that of "preparing, conducting, and evaluating, with maximum objectivity and scientific control, experiments with concepts, organization, doctrine, and procedures for future combat, as directed by the Commanding General, CONARC, including experiments for integrating new equipment into present-day organizations."

This mission may be rephrased into that of providing basic data, or facts, upon which to design military organizations, weapons systems, and tactics and techniques for a generation ahead.

The basis for the operation of the Combat Developments Experimentation Center, or CDEC, is simple. Factual data does not exist covering a surprising amount of military operations.

For many years the large-scale maneuver or the special test served as a vehicle for coming to conclusions on new devices and procedures. It was generally agreed that for test or experimentation purposes results were unsatisfactory. Definite plans were lacking for controlling activities to the end that unbiased results occurred. The end products were subjective opinions of so-called experts in which differences of opinion were more common than otherwise.

Proving ground data on weapons is exhaustive when it comes to lethality and predicted performance under ideal conditions. However, figures on the time required to engage a target by average draftees, time to emplace or displace, and many other data of vital importance to war gaming and other types of analysis are missing. Technical service predictions as to the characteristics of various types of equipment frequently are not borne out by field experience.

Most important of all, high-speed computers now offer the capability of studying large-scale weapons systems, the strategic employment of divisional and higher units, logistical systems, and many other complicated subjects which have to date defied analysis because of their complexity. Yet computer studies are useless unless the basic data which are put into the computer are comprehensive and valid. CDEC, by confining its experimentation

Controlled field experimentation presently being conducted by military-scientific teams is an outstanding contribution to the knowledge of our future leaders and also to the state of training of our Army units

to the behavior of smaller elements, can obtain a storehouse of data which not only apply to the experiments of the moment but which will form the basis of large-scale analyses perhaps saving billions in lives and matériel.

The mission of CDEC includes the phrase "maximum objectivity and scientific control" and it is a phrase of major importance. It means that for the first time in field operations a military-scientific team has engaged in the design, conduct, and analysis of field experiments. Essentially, it has meant placing the "war game" on a practical and factual field footing.

The conduct of experimentation has placed the Army officer-planner and leader in a new environment. His experience and training have accustomed him to drill, to maneuver, and to engage in combat for the purpose of gaining tactical experience or of defeating an enemy. The new primary experimental purpose of obtaining data is something else again and requires a quite different approach and different handling. The officer-planner finds that a pet technique or a scheme of maneuver taught him in a school may be completely unsuitable to the extent that it may compromise the validity of a major experiment.

Colonel Wesley W. Yale, United States Army, Retired, was graduated from the United States Military Academy in 1922; the Cavalry School, 1930; the U. S. Army Command and General Staff College, 1939; and the Naval War College in 1942. During World War II he commanded Combat Command B, 11th Armored Division through the Ardennes and Central and Eastern European Campaigns. Other assignments include duty as Editor of ARMOR *magazine; G3, Fifth Army; Command Inspector, Communications Zone, France; and Director, Department of the Army Exercise* Hilltop *in 1954, at which time he was retired. He presently is serving on the staff of Stanford Research Institute (Combat Developments Experimentation Center), Fort Ord, California.*

He faces the fact that he is being asked to measure something and to obtain reasonably precise results. Yet he learns that the military dictionary which has served him for many years is quite inadequate to define what he is being asked to do. Words like "mobility" or "firepower" convey different meanings to different people although they have been in general use for generations. But they must be given a precise meaning if the data to be gathered, and which is destined for computer problems, is to be factual.

The discussion which follows is intended to outline some of the problems which must be faced by an officer undertaking a military experiment as a member of a military-scientific team. Of course, it would be helpful if he himself were a Ph.D., but it is not at all necessary. In fact, it is even more helpful if he knows his job thoroughly as it affects weapons systems and tactical movement.

Temperamentally, he should be of an inquiring turn of mind and able to evaluate objectively the opinions of others. Ideally, he should have a thorough grounding in the conduct of tank-infantry-artillery-engineer-tacair combined operations and be able to apply his knowledge to problems involving weapons of the future. However, this is only a fraction of the real requirements and perhaps the less important fraction. For there must be a blending of scientific knowledge and military knowledge in every experiment. In general, it is easier for the scientist to comprehend the military requirements than for the soldier to understand the scientific. The military, by failing to analyze the real meat of any problem or to adapt military techniques to the necessary measures for scientific measurement, may cause an entire experiment to be thrown out of gear. Worse, it may be carried to a conclusion only to realize that the data are not valid and that the results are, therefore, worthless.

The soldier-scientist need not be a tech-

nologist in the sense of being a mathematician or physicist, although technical knowledge of operations research methods certainly would help. But it is vital that he understand *what* the scientist is trying to do, *why* he is doing it, and to a certain extent *how* it is to be done. Then, once executed, an experiment which has enjoyed joint cooperation can be turned over to mathematical analysts with full confidence that the resulting figures will be valid and meaningful.

What the scientist does to support military field experiments perhaps may be illustrated by an analogy, however remote the comparison may appear to be at first glance.

Consider a project to determine who, among a group of women's clubs, is the best cakebaker.

The project or contest committee, acting in the role of the scientist, might draw up a set of rules or procedures. First, would be an elimination of unlikely candidates by simply asking each club to nominate its best bakers so that the field would be reduced to a workable size.

Then, a standard cake recipe and a standard list of ingredients might be prescribed together with a schedule whereby each contestant or candidate is required to bake a cake in her own as well as in each of the other's kitchens.

Immediately, a howl of protest might well be expected. Mrs. Jennie Jones, for example, and her club backing her up, will stoutly maintain that she has never baked a cake elsewhere than in her own kitchen, with her own recipe, and that her product always has won the prize at the County Fair; in fact, this was the reason for her entering the contest.

Since Mrs. Jones probably is only one of many who have misunderstood the purpose of the contest, it is necessary to redefine the objective as determining the best cakebaker rather than the best cake.

Of course, rules to cover all contingencies must be prepared and a group of umpires chosen to see that one of the ladies does not slip in an extra egg or a special mix which will bias the results in her favor. Most important of all, the criteria for what constitutes the characteristics of a top baker must be stated, if possible in terms of numbers. The measure of quality, of course, involves quality of product, which is not easy to express in terms of numbers, since a certain amount of subjectivity on the part of umpires or judges is demanded. In any event, it is certain that each contestant must bake a considerable number of cakes in order to establish beyond any doubt that it is her skill that has triumphed and not some special ingredient or condition of environment which is responsible.

This little analogy points up most of the characteristics which are inherent in any military experiment. Some of these can be listed as follows:

Philosophy or method of selection by comparison.

Clearness of purpose.

Nomination of reasonable candidates.

Measures of effectiveness (criteria).

Experimental design or schedule of events.

Training.

Objective and precise umpiring.

Control.

Collection, processing, and analysis of data.

The remainder of the discussion will be devoted to an analysis of these characteristics and how each applies to the conduct of a military field experiment.

Philosophy of Experimentation

These are hard words, to quote the White Rabbit in *Alice in Wonderland* (practically a standard book of reference in these days of *Sputniks*). In essence, the philosophy of experimentation means that when some piece of hardware, some concept, or some organizational system is "tested," some criteria other than that of "go" or

"no go" must be found. In fact, we do not actually "test"—we take a number of alternatives and determine the relative merits of each.

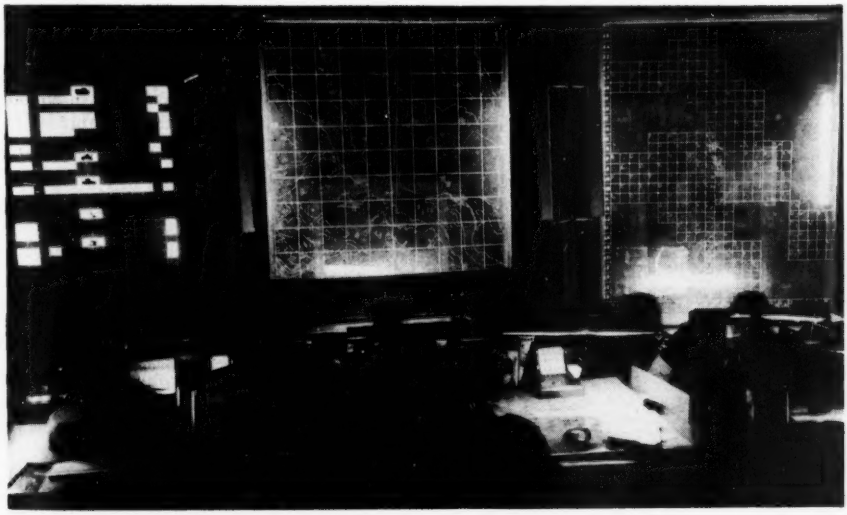
The "go-no go" system has been at the root of all testing in the past. A problem has been brought into the field, be it a gun, a vehicle, or a tactical concept, and its behavior studied under the conditions which might exist locally. It is said to "work" or not to work. In the end we are left with the question of what might have happened under a variety of conditions. Was a vehicle tested as a vehicle without considering that it was ultimately to be used with a complicated weapons system?

The "go-no go" system can cost millions and yet either produce no answers or an answer which results in going into production with hardware, or maybe with only ideas, which have to be junked when reality has to be faced. The true philosophy of experimentation is that of making an objective comparison between a reasonably proposed number of alternatives. For example:

What is the order of merit of several tanks designed to perform the same or similar missions?

Which is the best of several weapons systems for an infantry company as regards their fire effectiveness, their mobility, and their susceptibility to control?

Which is the best of several techniques for displacing artillery or other types of indirect fire types of weapons?



Three of the control panels used in field experiments at the Combat Developments Experimentation Center (CDEC) as viewed from the desks of the artillery umpires

Ideally, the scientist designs experiments to answer questions of this type so that in the end there can be no characteristic, no environment, or no technique of employment which has not been considered. Usually, the system involves holding a series of two-sided exercises in which several "blue" units, illustrating variations of the concept under experimentation, are pitted against one or more aggressor units. The result is an order of merit factual score of the systems under consideration.

The winning system may be adopted directly for service use, after analysis of the data and action by appropriate headquarters, or the figures may be given further analysis as a lead to an additional variation of systems.

It is very difficult to argue that the old system of organizing a huge maneuver costing millions of dollars to test something or other which was duly buried by confusion can be compared with the expenditure of a few thousands which test not one but several systems in an environment free of bias. The philosophy of comparison of candidates, therefore, whether the candidate is an idea or a piece of hardware, is the basis of all scientific experimentation using operations research methods.

Clearness of Purpose

To say that any experiment must have a clear purpose might seem fatuous to the uninitiated. How can anything succeed without a clearly understood purpose? How, indeed?

Yet anyone who has ever composed a staff study under the prescribed military services' format has had to consider carefully the purpose of the study. After devoting every consideration to it, he usually goes into the statement of the various factors and the discussion only to discover that perhaps his purpose was not quite right in the beginning.

The cakebaking analogy serves well. Mrs. Jones objected to the experiment and its demands for a common recipe and the use by contestants of a variety of kitchens. She had her own idea that the purpose of the experiment was to determine the best cake and that naturally the best cake must have been baked by the best baker. This is not necessarily so.

A common fault in prescribing the purpose of an experiment is to call for the measurement of something or other in so many different ways that a complete confusion results. For example, a company is to be observed handling a weapons system in attack, defense, delay, pursuit, screening, exploitation, riot duty, river crossings, and reconnaissance. To make all these observations would require years of experimentation just to bring out the fact that the author of the directive had not neglected his schooling but had included just about everything that a small unit could possibly be expected to do. In reality, the points observable in attack, defense, and delay serve to bring out everything of which the omniscient author might have been thinking.

As an example, let us take a purpose of "determining the relative merits of several types of reconnaissance platoons in carrying out reconnaissance and counterreconnaissance missions for a parent infantry company."

The key phrase here is "parent infantry company" and it may be supposed that the person who initiated the experiment desires to determine whether specially designed reconnaissance elements are necessary to modern infantry where so much motor transport exists.

If so, then the mistake must not be made of designing an experiment to depict the infantry platoon operating deep in enemy territory, engaging in major combat while acting alone, and in general attempting to do things normally associated with the reconnaissance element of a regiment or division. This must be a reconnaissance element performing close-in missions to obtain information of value to the company commander. Any other environment defeats the purpose of the experiment.

Many other examples could be cited where the data procured could be expected to bear on almost anything except the purpose intended.

Semantics

An unfortunate aspect of field experimentation and analysis is found in the large number of everyday military terms which cannot be exactly defined. This fact

is surprising to the professional who is accustomed to the use of these words—the better his education, usually the greater his surprise. A clear understanding of the meaning of critical words is essential before any experiment can be undertaken. The alternative is the acceptance of an expensive operation which may or may not develop in the manner which the initiator of the idea intended.

For example, what is "control?" You cannot find it in the military dictionary in its tactical sense, nor does Webster help a great deal.

It has lately been defined as "the characteristic of the ability of a command and staff to direct the activities of a group of subordinate elements toward a common goal in an accurate and timely manner." This definition is not presented here necessarily as the correct one. In fact, many readers may quarrel with it. But it is unfortunately true that no field experiment in which control is a major factor can be planned until each element of this definition has been examined and a corrected version concurred in by everyone. Otherwise, the experiment may be planned to depict a unit operating with all its elements on independent missions. An operation of this latter kind might test a commander's ability to plan and to compose and issue a field order, but where no coordination or regulation is required, there certainly is no test of control. The same is true of words like "firepower," "mobility," or phrases such as "protect the left flank." They are, in fact, vague generalities which fall flat when an attempt is made to be explicit. And it is essential to be explicit when valid data are the objective.

"Bubble-house" control headquarters for field operations is kept inflated by air pressure. The structure houses administrative personnel and equipment to process and interpret umpire reports emanating during a field experiment.—US Army photograph.

Semantics, however, are only part of surprising sources of misunderstanding. Performance data of vehicles and weapons are not always what they appear to be in the books. Take the matter of mortar

firing, for example, where it is simple enough to find proving ground data on the lethality of various types of ammunition at various ranges. When experimentation involves two-sided exercises, as most of it does, some means of simulating mortar fire must be found. It is quite possible to use the lethality tables and range tables, but nowhere is there any data source on which to base performance time of putting a mortar into action, registering the weapon, and firing for effect. Yet to be accurate all these have to be played into two-sided exercises. Side tests to determine performance times required have to be staged. The side tests must contemplate the use of average figures for a large number of crews at various states of training, as would obtain during a mobilization emergency, or in battle where a proportion of replacements are found among weapons crews.

As a rule many experienced officers are again surprised at the long time taken to get mortars into action, or the short ranges at which tanks are engaged by preference by antitank weapon crews. All this activity is essential, however, if basic data are to be produced on which an experiment is to be conducted. In addition, these data are of inestimable use in war gaming with electronic computers to determine the outcome of map exercises involving large-scale tactical concepts or weapons systems.

Nomination of Reasonable Candidates

A decision to include a candidate which has very little chance of competing with the others proves nothing and wastes experimental time, usually at a premium. If there is no reasonable alternative to a proposal, whether it is a proposed organization or a weapon, then it becomes a question of simple workability. But this condition does not occur often and the need for a straw man does not arise. However, "straw man" should not be applied to what is known experimentally as a "frame of reference" which means essentially, that when experimenting with new ideas there should be some reference to what has been known and accepted in the past.

Assume that several new vehicles have been developed for carrying cargo. An experiment is set up and after exhaustive field runs it is determined that a certain relative merit exists. Are we then justified in saying that Truck "A" should be adopted by the service as better than the well-known 6 x 6 when the 6 x 6 was not included in the experiment? Naturally not. In this case the 6 x 6 was the "frame of reference" which should have been made a part of one of the candidates for the experiment, which may well have resulted in conclusions that none of the new candidates were sufficiently superior to the standard 6 x 6 to warrant any changes.

Criteria or Measures of Effectiveness

It is in this field that the military man may well realize that his knowledge of his profession is by no means as comprehensive as he thought. He becomes a more or less unwilling participant in discussions relating principally to semantics, as in the case of determining the purpose of the experiment, except that in the field of criteria there is a need for greater precision.

The criteria or measures of effectiveness are simply those characteristics which make a weapon, organization, or concept good in relation to similar candidates.

We have spoken of the difficulties of defining "firepower." If we set out to measure firepower or fire effectiveness, however, we run into the fact that firepower works for us not only when it kills the enemy or destroys matériel, but when its moral effect is such as to deter the enemy from carrying out operations by reason of fear of losses, individually or collectively.

A weapon or weapons system certainly is an element of the "firepower" available to a commander. But the effectiveness of

the weapons may be varied by a number of factors, such as the power of the projectile, the mobility of the weapon, and the environment in which it is used. Further, the ability of the leader of the forces to choose suitable missions and to control the weapon or weapons system is a most vital factor in its effectiveness.

In the cake-baking analogy, where the purpose was to determine the relative merits or skills of several bakers, the cakes are the products and the obvious principal measures of effectiveness. They may not be the only measures, since cleanliness and the time taken to prepare the product also may figure. Yet within the cakes lie the characteristics of taste, texture, and lightness.

The products of firepower are casualties and the fear of casualties. Under similar conditions of employment the weapons system which produces the greater number of casualties in comparison with another system may be said to be the better system.

The fear of casualties or the moral effect of fire is another thing. It can be argued that the moral effect of fire is directly proportional to the physical effect and that, therefore, the casualty ratio will express inherently both the moral and physical effect of the fire. Perhaps not everyone will agree, but where experimentation must be carried out without the ability to inflict real casualties in a two-sided operation, is there any better criterion, assuming that there is a valid yardstick for assessing casualties realistically?

Casualties may not always be a criterion in a two-sided experiment. Suppose we wish to measure the ability of a commander to control a unit of given size and composition, a simple test of leadership. Assume that the commander-candidates are given a certain problem of execution involving their ability to mass widely scattered elements for the rapid attack of an enemy position. En route to the attack position a platoon of five vehicles suffers the loss of a single vehicle to long-range fire. Does this alter the commander's control problem? The platoon leader's problem slightly; that of the company commander not at all. But suppose that four or five of the platoon vehicles are destroyed. This definitely does present a new control problem to the company commander since one of his elements has become ineffective and his entire plan probably requires alteration. But just at what point does the casualty factor become a criterion?

We already have touched on the criteria of reconnaissance where the number of items of information obtained by the candidates is one of the essentials. But what of two candidate platoons, one of which obtains an accurate picture of enemy dispositions in two items while the other sends in 20 messages of terrain conditions? Obviously, there must be a weighting system introduced somewhere for reconnaissance.

Weighting factors to be measured is highly undesirable and is to be strictly avoided because of the introduction of personal judgment into the measurements. Any variety of subjectivity is most undesirable since it will bias an experiment to a degree and the degree is nearly always unknown. As will be shown later, it is possible to work out an umpire system which is almost completely objective in character and in which facts and facts only are amassed as data. Measurement of time and casualties are inviting criteria because of their objectivity. However, where a degree of subjectivity is required, the experiment is not necessarily invalid on that account. We say that after a hundred odd games the Yankees won the pennant beyond any argument as to relative skill, yet umpires made thousands of decisions objectively, and in the beginning someone had to decide what constitutes

an "out" or why it takes three strikes to retire a batter. In football there is a continuing controversy over the validity of the point after touchdown as a criterion or measure of effectiveness of two teams. In our cakebaking analogy someone in the end must taste and judge the cakes.

Casualties, time, the amount of information, and like criteria are all manifestations of other criteria. Casualties become a function of fire effectiveness, time is a function of mobility, and information a function of reconnaissance. The higher degree of the criteria usually is expressed in the purpose of the experiment and the lower degree of criteria then becomes the "measures of effectiveness" or what we actually measure to obtain the criterion expressed in the experimental purpose.

In addition to measures of effectiveness, we have mentioned other factors such as leadership, terrain, and learning (where experimental troops tend to become more proficient as an experiment goes on and thereupon introduce bias). All these factors are experimental variables. Some we want to measure and others are called "nuisance variables." They are there but we wish they could be avoided. We prefer where we are not specifically measuring leadership to have leaders of experimental troops of exactly equal skill. We prefer to work over a variety of terrain in order that a particular result cannot be suspected of being due to some influence of favorable or unfavorable ground. We want to avoid the influence of troops getting better as the experiment moves along so that their last efforts will not reflect the best measurement, regardless of facts.

Experimental Design

Entire volumes have been written on the subject of experimental design in operations research, so more than a brief mention is not possible here.

An experimental design does two things. First, it sets up a schedule of operations, exactly in the manner of the National League baseball schedule every spring. More important, it aims at either eliminating or at least minimizing the influence of the "nuisance variables" cited above.

As an example, here is an experimental design called the "Greco-Latin Square" which is only one of many designs but which serves to illustrate the minimizing of nuisance variables.

	A	B	C	D
I	W_2T_2	W_3T_3	W_1T_4	W_4T_1
II	W_4T_4	W_1T_1	W_3T_2	W_2T_3
III	W_1T_3	W_4T_2	W_2T_1	W_3T_4
IV	W_3T_1	W_2T_4	W_4T_3	W_1T_2

This design is typical of an experiment where four experimental units (A–D) work with four different weapons systems (W) over four different terrain "courses" (T) in four phases (I–IV).

If only one unit was used on four weapons systems successively, probably learning would intervene to make the last run of the experiment look best, as has already been pointed out.

If four units A–D worked out each with a different weapons system, the best leader probably would make the system he demonstrated look best regardless of facts.

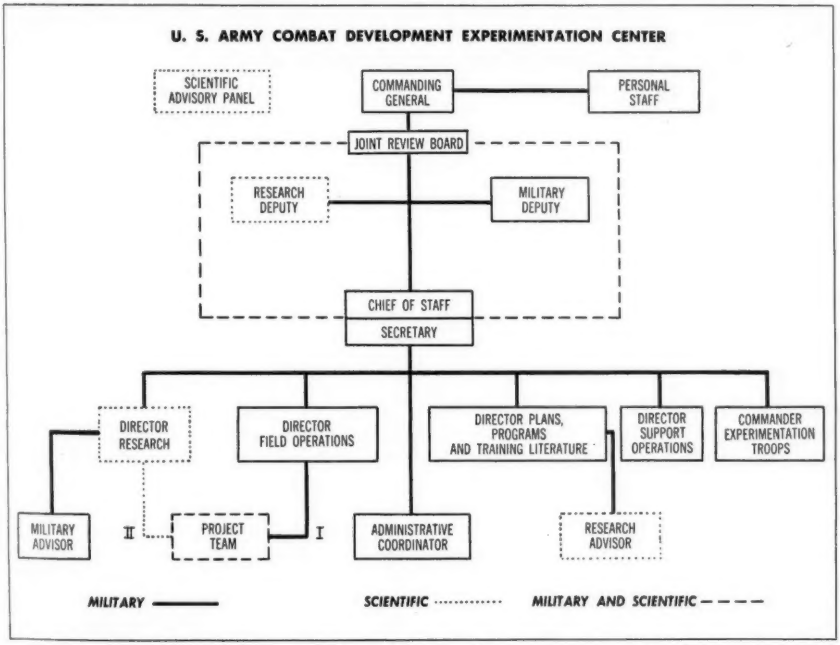
If each unit worked on different terrain, the effect of terrain on the results might be suspected.

Thus the schedule has called for Phase I to have Unit A try Weapons System W_2 on Terrain T_2, while the other three units try other systems on other terrains. At the end of Phase I units begin training under a different weapons system so that in Phase II Unit A tries Weapons System W_3 and other units rotate similarly both in weapons system and terrain.

At the conclusion of Phase IV the nuisance variables have been canceled out or minimized. Of course, the greater the scope of the Latin Square (say a 6 x 6 design instead of the 4 x 4 shown here) the greater the probability that the nuisance variables have been canceled.

The 4 x 4 design shown obviously requires 16 runs of the experiment. With preliminary or practice runs the total probably is 32. If the unit involved is company size, this takes a considerable amount of time and large numbers of men, and the importance of the experimental purpose must be commensurate with the time and funds expended.

Moreover, once a Latin Square design schedule is begun, it must be finished without varying the conditions in any way or the results will be biased accordingly. Thus if a personnel turnover in Unit A occurs between the phases, the results will be compromised accordingly. Or, if a change in the scenario is considered advisable, it cannot be made without affecting the ultimate result of the experiment. Nevertheless, where facilities are available, a Latin Square of at least 4 x 4 in scope can be depended upon to produce highly valid data. Where factual data can be produced which can be utilized to validate large war games on electronic computers where highly complex tactical and supply systems are involved, the initial cost becomes relatively insignificant.



If facilities are not available for so many runs, a design may be worked out where matched pairs are compared through a series of exercises much as a field trial is run for bird dogs. Conditions may be varied between runs without compromising the data.

Designs may be sequential in nature where, once a set of results is obtained,

conditions may be varied and a new sequence begun. For example, at the Combat Developments Experimental Center the initial concept for comparing the effectiveness of future infantry units of company size was first to run a Greco-Latin square design to determine the best of four firepower systems. The best firepower system then was to be kept constant through the next sequence where the mobility system for the company was varied. Finally, the best firepower system and the best mobility system were to be kept constant while the size and composition of the unit was otherwise varied.

Many operations research scientists look askance at a 4 x 4 design on the grounds that a hundred or more samples are necessary to eliminate bias. However, the input data for field experiments are real and it usually is sufficient to establish a trend rather than the precision associated with a chemical or engineering experiment.

Training

Training has a most important influence on experimental results regardless of what safeguards may be used in the form of experimental designs. A group of mediocre pistol shots may have a contest to determine the best shot by firing at a half dollar at 50 yards. Since no one will hit the target in all probability, the chance of discriminating between shooters is remote. Similarly, experiments to evaluate weapons systems where none of the candidates understand any weapons system has scant chance of success.

On the other hand, to undertake an experiment with a group of experts where the object of the experiment is to determine something which ultimately will be subject to personnel of mobilization training experience also can be misleading.

The solution appears to lie in pointing the training to the exact requirements of each experiment by publishing to the troops scheduled for the experiment such items as its purpose, its measures of effectiveness, its scoring system, and the general nature of the scenarios. A training schedule then can be drawn to bring troops to the desired degree of skills.

Some system of training management must exist where the agency charged with experimentation can assure itself that troops are being readied in the proper manner. However, the ordinary systems which obtain in every military installation and which are prescribed by appropriate training manuals are quite adequate.

Unfortunately, manuals themselves are not entirely adequate. It has been the fashion for many years to say that military principles never change and that new tactics consist merely in a different application of principles. Possibly this is true. However, several factors are present which invalidate such a statement. For one thing, the various crises of the past 15 years have forced a very high degree of troop rotation with the result that few units ever gain much experience in small unit phases of the training cycle. The proportion of officers experienced in handling units of combined arms, to include the timing of fire and movement tactically, is entirely too small.

Again, we are embarked on the atomic age which manifestly requires a return to a tactical dispersion not seen since the Plains Indian wars and which naturally requires a higher type of leadership than the stylized tactics of World Wars I or II and, in particular, than the closing phases of the Korean war. Tomorrow's leader must act fast and act largely on his own while having access to long-range weapons which must be timed to the actions of his own unit. This sort of thing is not for the tyro. Training, and lots of it, is the only answer.

It is impossible to escape the notion that the Army's best trained units inevitably must emerge from their period of service

as experimental troops. Rotation of all troops through different experiments certainly would raise training standards everywhere and, incidentally, prove a solid asset hidden among the costs of experimental budgets.

Manuals now are being written on a temporary basis to cover experimentation now in progress. In the age of *Sputniks* one wonders whether the printed page will ever catch up with the requirements of the field.

Umpiring

In developing an umpire system, the Combat Developments Experimentation Center probably has provided a complete justification for its existence to date regardless of any other achievements. The system is admittedly complex and will not be described here except to state its potential.

The system uses umpires who are in the main average soldiers and who need not possess any unusual qualifications. They are equipped with forms, stop watches, and radios and are required to report only facts and not opinions.

Exercises are conducted over territory which is staked out so that umpire locations may be reported by references to stakes. Troops do not have stake reference capability but work through normal military maps.

Umpires report locations and the initiation of fire missions to a central control board manned by experienced personnel. At the board, progress of each element of the experimental troops is played by markers on a map grid. Ranges and locations of prospective targets are reported to the board where, by reference to a manual based on the hit probabilities of the weapons for the particular conditions under which it is firing, the casualties assessed are relayed to the umpire of the unit fired upon who then assesses casualties on the spot. In the case of high-angle fire weapons like mortars, casualties can be assessed faster than they would occur in actual combat. Direct fire weapons are less satisfactory and the system constantly is being improved.

The important feature is that the umpire system is factual to a degree not existing even in games such as baseball or football. No one expresses "opinion" opinions but simply reports facts as they occur. Casualty assessments are based on a table of random numbers so that over a period of time chance is ruled out. Without a completely objective system, the data which is produced by the experiment would always be open to question.

At the same time, experiments offer a fine opportunity to observe many military actions and it is helpful to provide subjective comment, particularly as to the *why's* of an action. When data are analyzed it often happens that a given action appears to have highly unusual aspects. If it is known from reports that in this instance a unit commander made a bad decision, the report can be used to throw out that bit of data and thus increase the validity of the remainder. Subjective comment is provided by a staff of military expert observers which is organized in extension of the umpire system, with their report paralleling that of umpires for cross reference.

Control

Experimental control means something different than unit tactical control. An experimental unit may be under complete control of its commander and yet throw an experiment completely out of control so that all data collected are subject to compromise. This happens when a unit is permitted to disregard normal security measures or otherwise to depart from realism, although violations of security—including use of cover—make up the great portion of unrealistic practice.

Experimental control is lost when two elements which are being compared are permitted to encounter different circum-

stances within similar situations. If we are comparing, for example, mobility in an attack, and one unit envelops the aggressor left through soft and marshy ground while in the next experimental run the next unit breezes around the right flank without difficulty, we are not comparing mobility as much as measuring a choice of terrain by commanders. Instances of this type must be controlled by ensuring moves around the same flank by each experimental unit in comparable situations, either through rigid control of aggressor or by other means in the scenario.

Experimental control resolves itself into a simple question of military discipline and training. For experimental purposes, no greater standard is required other than those laid down in appropriate training regulations. At the same time, the necessity for complete control cannot be overemphasized. Without it the all-important data are worthless.

For lack of space the need for troop motivation through the long series of situation repeats which are required by experimentation can only be mentioned. It is the same motivation to excel which must exist in any good unit and is, therefore, a product of good discipline, training, and leadership.

Data Collection and Processing

If we grant that the best baker does not always produce the best tasting cake, we must have figures to back up the statement. Most people will want the best cake regardless of the real purpose of the experiment. Only the baking industry wants to hire the best baker. In the military field we are trying to eliminate the factor of which leader, or which baker, is best. It is the product, the concept, the tactic, or the weapons or mobility system we are trying to determine. But in every case we must have figures.

A good umpire system produces raw figures which of themselves are not too illuminating. Generally, there are so many as to constitute an overwhelming problem. Fortunately, in the last decade the electronic computer has been developed for the solution of overwhelming problems. In any event the processing of the data requires a trained scientist with a statistical background. He has no interest in who won.

The scientist will come up with cold figures. He may show that in comparing weapons systems, System A scored 550 according to the conditions of the experiment, while System B scored 540. But the experiment did not go into the comparative cost of the systems in terms of dollars. The Army can then conclude that the systems are not essentially different and select the less expensive system.

It is important for the military man to keep in mind that the entire objective of experimentation is the data which it produces. His every effort must be directed toward the end that the product shall be as valid as it possibly can be. If he does so, the experiment is a success. If he does not, it is a failure.

Conclusion

Field experimentation by military-scientific teams is one of the greatest contributions in history to the military profession. It is thoroughly practicable and, in fact, not difficult provided the normal standards of everyday military practice are carried out.

At the present time, it requires special scientific support particularly in the fields of experimental design and data analysis. As military experience with experimentation grows it is logical that the necessary knowledge for all phases of action can be acquired by military men. It is quite likely that those who are able to produce the data so sorely needed for large-scale map maneuver experimentation will not only be masters of their profession, but will be the hidden, real heroes of tomorrow's wars.

MILITARY NOTES AROUND THE WORLD

UNITED STATES

Linear Atom Smasher

A two-mile-long linear atom smasher is scheduled for construction. The big accelerator will be built in a subterranean tunnel and will generate power up to 45 billion electron volts. The new project, which will take seven years to complete and cost over 100 million dollars, will use 1,000 klystron tubes to drive its electron bullets. The largest atom smasher at present is in the USSR. The Soviet research project (MR, Dec 1956, p 71) is of the cyclotron type which whips protons around in a circle to accelerate them.—News item.

Marines Adopt New Rifle

The United States Marine Corps has announced the adoption of the *M-14* rifle and the *M-60* general-purpose machinegun. Both of these weapons are chambered to use the 7.62-mm NATO cartridge. The *M-14* rifle, previously adopted by the Army, weighs about a pound less than the *M-1* of World War II fame. It has a 20-shot magazine, compared with the eight rounds of the *M-1*. It can be operated for automatic or semiautomatic fire, and has a rate of fire of 200 rounds per minute. It will also replace the Browning Automatic Rifle (BAR) in infantry fire teams. The *M-60* machinegun which has an integral bipod, and can be used with a tripod mount, also was adopted by the Army and will replace three different types of machineguns. The Army, which had planned to begin the changeover to the new weapons in 1960, has ordered a speedup in production of the *M-14* rifle. It is estimated that 20,000 to 25,000 of the new weapons will be produced per month when the production is in full operation.—News item.

Spiral Wrap Shell Case

A spiral wrap steel 105-mm shell case has been test fired successfully. The new shell case, developed by the US Army Ordnance Corps, is expected to save about one-third the cost of shell manufacture. Conventional drawn shell cases average $2.25 each. The spiral wrap method reduces the cost to about $1.50. The new case is assembled from three pieces—a forged base, a wrapped body, and a stamped collar. The body is formed by rolling a preformed sheet of steel in the same way a sheet of paper is rolled to form a hollow cylinder. All parts are made of standard commercial grade, nonstrategic steel that is readily available in wartime. It is expected that a spiral wrap production unit, which occupies only half the space required to produce earlier types of shell cases, also will increase the production of cases by about 80 percent.—News item.

Battery Vest

A battery vest utilizes human body heat to keep dry cells warm and active for radio operators in extremely cold weather. The vest is worn under a parka to capture body heat, and a cord is used to connect the battery power source to standard Army radios. Dry cell batteries go dead rapidly

US Army Photograph

Body heat keeps dry cells operating

in extreme cold which slows down their electrochemical action. With the special vest, batteries developed for low-temperature use are expected to stay in service as much as 10 times longer than in the past.—Official release.

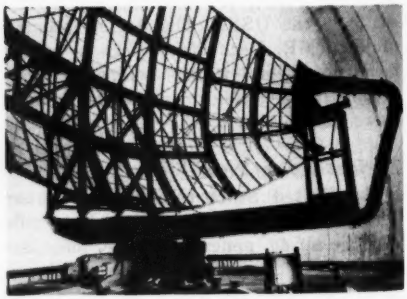
Helicopter Lays Wire

A faster and more efficient method of laying field telephone wire by helicopter is under test. The new method includes the use of aluminum dispensing tubes mounted vertically in the floor of the aircraft. Three half-mile spools of field wire, prespliced for continuity, are placed in each dispenser. Other prespliced coils of wire are carried and are readily available to reload the dispensers.

A new dispenser under design will permit the laying of wires of any length, limited only by the cargo capacity of the helicopter. During the laying of the lines, a constant check on the progress of the operation is made by telephones connected to each end of the wire, permitting the early detection of breaks or short circuits. During tests, approximately 500 miles of wire were laid at speeds up to 70 miles an hour. It is estimated that five light helicopters using the new method will be able to lay the entire 120 miles of telephone network of an airborne division in less than 15 minutes.—News item.

'Missile Master' Radar

An advanced long-range search and height finding surveillance radar has been installed in the Army's *Missile Master* System at Fort Meade, Maryland. The radar, known as the *FPS-33*, utilizes a high gain antenna that increases the range of the system by more than 50 percent. The antenna operates within a protective radome. The system also incorporates a



Antenna of *Missile Master* radar

moving target indicator (MTI) system which accents the radar signal reflected by moving objects and decreases the indication of fixed objects and ground clutter. The Fort Meade installation was the first *Missile Master* placed in operation, and currently is in use in the defense of the Baltimore-Washington complex.—Official release.

AAA Units Redesignated

Brigades and groups of the U. S. Army Air Defense Command (USARADCOM) formerly called Antiaircraft Artillery, have been renamed air defense artillery units. The change emphasizes the shift Army air defense forces have made from antiaircraft guns to the modern surface-to-air missiles during the past four years. —Official release.

Air-to-Ground Guided Missile

The Navy's *Bullpup* is the first air-to-ground guided missile especially designed to provide nonnuclear fire support to ground troops and for use against tactical targets. The *Bullpup* is a supersonic, solid propellant missile that is radio-controlled in flight by the pilot of the launching aircraft. The 10-foot-long, 600-pound weapon can carry a variety of 250-pound loadings, and reportedly attains a speed

US Navy Photograph

FJ-4* fighter with pylon-mounted *Bullpups

of Mach 1.8. The missile is simple in construction and maintenance, and extremely accurate. A first test by one pilot is said to have resulted in a hit on a four-inch target at a range of two miles. The *Bullpup* has been tested in *AD6*, *FJ-4*, and *A3D* naval aircraft and in the Air Force's *F-94 Starfire* all-weather fighter. Fleet delivery of the missile is scheduled for the near future, and both Navy and Marine aircraft will carry the weapon. The Navy presently is using a load of six missiles per plane.—News item.

Fast Teleprinter

The first of a new family of superspeed combat teletypewriter units can print a message more than 10 times as fast as standard teletypewriter equipment. The device, which can record messages at the

US Army Photograph

High-speed teletypewriter

rate of 750 words a minute, does not use ordinary typing keys. Instead, a wheel rimmed with letters and spinning at 3,750 revolutions a minute is used. At the precise instant the correct letter comes into position a tiny hammer slaps the paper against the type wheel. It types out messages on a ⅞-inch paper tape, and at the same time punches out coded holes. The tapes come out of the machine at seven and a half inches per second. The printer mounts in a jeep or truck for use in a forward area communications center.—Official release.

COMPARISON OF UNITED STATES AND SOVIET SATELLITES

	Explorer I	*Explorer III*	*Vanguard I*	*Sputnik I*	*Sputnik II*	*Sputnik III*
Weight	30.8 pounds	31 pounds	3.25 pounds	184 pounds	1,120 pounds	2,919 pounds
Shape	bullet	bullet	sphere	sphere	cone	cone
Size	80 x 6 inches	80 x 6 inches	6.4 inches diameter	22.8 inches diameter	19 x 4 feet	11 feet 9 inches by 5 feet 8 inches
Date Launched	31 January 1958	26 March 1958	17 March 1958	4 October 1957	3 November 1957	15 May 1958
Lifetime (Est)	3 to 5 years	3 months +	200 years +	2 months	162 days	6 months
Maximum Altitude	1,587 miles	1,741 miles	2,466 miles	560 miles	1,056 miles	1,168 miles
Minimum Altitude	219 miles	117 miles	405 miles	145 miles	150 miles	150 miles
Payload	11 pounds of instruments	11 pounds of instruments	radios and batteries	radios and batteries	dog and instruments	instruments
Initial Orbit Time	114.5 minutes	115.7 minutes	134 minutes	96.2 minutes	103.7 minutes	106 minutes

Warships Reclassified

An attack carrier and three heavy cruisers have been reclassified and given new hull numbers. The heavy cruisers converted to guided missile craft (MR, Mar 1958, p 68) are the *Albany (CA-123)*, *Chicago (CA-136)*, and *Fall River (CA-131)*. They have been given hull numbers of *CG-10*, *CG-11*, and *CG-12* respectively.

The *Oriskany* class attack carrier *Hornet (CVA-12)* will become an antisubmarine warfare support aircraft carrier with the hull number of *CVS-12*. The *Oriskany* class vessels are improved versions of the *Essex* class. The improvements include angled decks, enclosed bows, and heavier decks and handling gear to permit the operation of bigger aircraft. Four of these vessels have been equipped to launch *Regulus* guided missiles. One *Oriskany* class carrier, the *Kearsarge*, has been fitted with an all aluminum surface to flight deck and elevators.—News item.

Versatile Vehicle

The *Unimog*, under consideration by the US Marine Corps, is a versatile, German-manufactured military vehicle that can be powered by diesel engines ranging from 34 to 155 horsepower. The weight of the vehicle, depending on the number of the crew, armament, and horsepower, ranges up to nine tons. The lightest version of *Unimog* can carry a 2,500-pound payload and pull 30 times its weight. When used as an armored car, the vehicle is fitted with a turret and can be used on hit-and-run missions. It can be equipped with a 40-mm antiaircraft gun or a 160-mm recoilless rifle. The armored car model has a speed of 30 miles an hour over rough terrain, and can travel twice that fast on smooth highways.—News item.

Safety Precautions

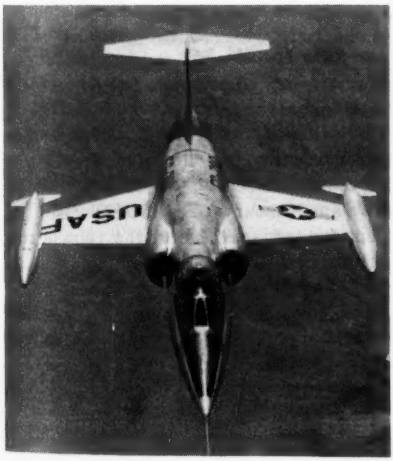
Elaborate safety precautions are being taken in the design of the United States first atomic merchant vessel, the *Savannah*, now under construction. These include a thick steel tank surrounding the atomic reactor, heavy steel and wood mats to protect the reactor in case of a collision at sea, and three separate emergency power systems. One of the emergency power systems provides electricity and power for an emergency propulsion motor, another for electricity, and the third for standby steam.

The *Savannah*, which will carry 9,340 tons of cargo and 60 passengers at a speed of 21 knots, utilizes an ultrareliable pressurized-water reactor that delivers 22,000 horsepower and can run three and one-half years, or about 350,000 miles, on a single fuel charge.

By way of contrast, the atomic reactor of the Soviet icebreaker *Lenin*, which is of the boiling water type, is expected to provide 44,000 horsepower for a speed of 18 knots, and will run a year before refueling becomes necessary.—News item.

Record Makers

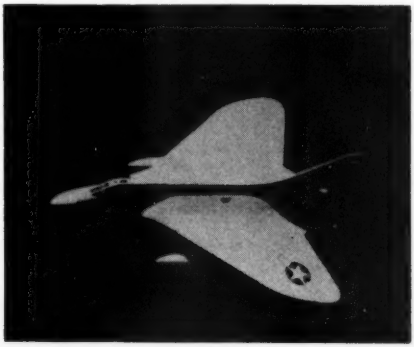
The *F-104A Starfighter* (MR, May 1958, p 64) has established new world records in both speed and altitude. The speed record of 1,404.19 miles an hour exceeds by more than 200 miles an hour that previously held by a *F-101A Voodoo* interceptor. The altitude record of 91,249 feet was set in a 27-minute flight from takeoff to



Record-making *F-104A Starfighter*

landing, and exceeds by more than two miles the height reached a week earlier by a French *Trident II* mixed power interceptor. The rate of climb of the *Starfighter*, which was designed to climb as fast as it flies straight and level, was not announced. Production models of the *F-104A* are powered by the *J79* turbojet engine. According to *Jane's All the World's Aircraft*, this engine delivers a thrust of 17,000 pounds with afterburner.

The rate of climb record is held by an *F4D-1 Skyray* fighter which reached an altitude of 49,213 feet in two minutes 36.05 seconds, narrowly beating the record previously established by a *Trident II* which reached the same altitude in two minutes 37 seconds. The *Skyray* has been operational with Navy and Marine units for the past two years, and is used by the North American Air Defense Command in



US Navy Photograph

Fast-climbing *F4D-1 Skyray*

France's *Trident II*

the role of all-weather fighter. The revolutionary *Trident II* is powered by two wingtip-mounted *Gazebo* engines, each with a thrust of 2,420 pounds and a *SEPR 631* rocket with a thrust of 6,732 pounds at takeoff. Further development of the *Trident II* has been terminated.—News item.

Infrared Devices

The instrument known as *LOPAIR* (long-path infrared) is capable of detecting air contaminants as far as a quarter of a mile away. The system employs a detector head—the source of the infrared light—and a self-aligning reflector unit which returns the beam of light to the detector. The detector head and mirror unit weigh 39 pounds and 15 pounds respectively, and can be set in operation in the field in less than five minutes. The

Infrared detection device *LOPAIR*

detector head analyzes the returned beam and sounds the alarm if necessary.

Other infrared instruments under test are the *T-1* weapons sight, *T6A* binoculars, and the *Scanrod T2*. Results of the tests of these devices have not been released.—Official release.

Plan for Teachers

The Department of the Army has announced a plan designed to interest active and retired personnel in the teaching profession as a postretirement career. The plan is expected to inform and motivate individuals who have baccalaureate degrees and special competency in science, physics, mathematics, history, and language to prepare themselves for teaching careers in high schools and colleges.—Official release.

Jet Smokescreen

A recently developed smoke tank will permit jet aircraft to create a smoke curtain that is free of the gaps and rifts common to other smokescreens laid down by the fast-moving jets. It can form a complete curtain from the ground to as much as 500 feet high in about 25 seconds, as compared to previous types which took from five to 25 minutes to complete action. The system utilizes small containers, all loaded with a standard smoke agent, and placed in a larger tank. When the main tank is opened, the smaller containers are dropped, some releasing their contents on the way down; the others do not open until they reach the ground.—News item.

New Role for 'M-56'

Experiments in which a 106-mm recoilless rifle has been mounted on a 90-mm assault gun *M-56* chassis have developed the combination into an effective weapon according to a report. No modification of the weapon, mount, or vehicle is required except for mounting bolts; the vehicle can be restored with ease to its original condition. The 106-mm rifle, two of which are organic to each rifle company, is used in the primary role of antitank protection. It has a muzzle velocity of 1,650 feet per second and a range of 8,400 yards.—News item.

'Galveston' Joins Fleet

The cruiser *Galveston*, which was christened 13 years ago and then placed in fleet reserve, has been converted to a guided missile cruiser and commissioned. The *Galveston* is armed with the *Talos* missile, and is the first US warship to carry such armament. The 14,000-ton light cruiser, which carries the official designation of *CLG 3*, is capable of a speed of 33 knots. Missile cruisers previously operational with the fleet are the *Canberra* and the *Boston* which are armed with the shorter-range *Terrier* missile.—News item.

GREAT BRITAIN

Warship Construction

Four large war vessels, including the aircraft carrier *Hermes* and three *Tiger* class cruisers, construction of which was started during World War II, are nearing completion. The *Hermes*, a modernized vessel originally of the *Centaur* class, displaces 27,000 tons, has a top speed of 28 knots, and will mount 45 aircraft. Its modernized equipment includes an angled deck, steam catapults, and deck-edge elevators. The *Tiger* class cruisers, the *Blake*, *Lion*, and *Tiger*, displace 11,700 tons and can attain a speed of 31.5 knots. As originally designed, the armament of these vessels included nine 6-inch, ten 4-inch, and 16 smaller guns. Current plans include a reduced number of weapons, but the vessels will be equipped with new fully automatic 6-inch gun turrets having a considerably increased rate of fire.

Construction of the peroxide-propelled, high-speed experimental submarine *Excalibur*, sister ship to the *Explorer* (MR, Jul 1957, p 69), has been completed.

Of the 44 new frigates authorized for construction since 1951, 17 are already in service and 14 others are under construction.—News item.

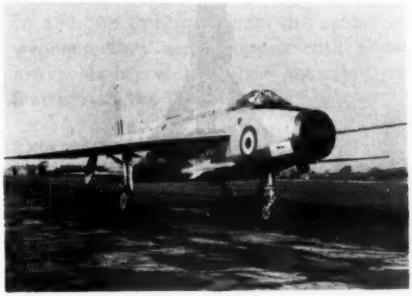
Strategic Weapons

British development of a ground-launched, multistage missile has been announced. It also has been revealed that *Vulcan* and *Victor* strategic bombers will carry a "stand-off," powered bomb which will permit the *V* class bombers to release the weapon many miles from the target and outside the range of surface-to-air defensive missiles. Details of the performance of the "stand-off" weapons have not been released. The 35-foot-long weapon is carried externally under the fuselage of the long-range bombers.

This weapon has been called "the ultimate defense weapon" of Great Britain. It is reported to be able to carry a thermonuclear warhead with extreme accuracy over a range of several thousand miles to a surface target. The multistage weapon will be about 70 feet long, 10 feet in diameter, and weigh approximately 70 tons. The rocket motors are to be tested in England, and final tests of the complete weapon will be made at the Woomera rocket range in Australia. No date for these tests has been indicated.—News item.

'P1.B' Interceptor Armament

The swept-wing *P1.B* interceptor aircraft mounts the *Firestreak* infrared homing guided missile as standard armament in addition to its two 30-mm *Aden* cannons. Two of the air-to-air rockets are carried on horizontal pylons attached to the speedy plane's fuselage.—Official release.



***P1.B* with *Firestreak* missile**

SWITZERLAND

Missile Development

The Swiss missile program includes the liquid-fuel *Oerlikon Model 54* and *56* surface-to-air missiles, and the antitank *Cobra 4*. The *Model 54* has a range of 15 miles, a speed of Mach 1.8, and weighs 825 pounds. The *Model 56* attains a speed of Mach 2.3. These weapons utilize beam-rider guidance with proximity fuze. The antitank *Cobra 4* is a solid propellant wire-controlled missile with a range of about a mile.—News item.

USSR

Light Bomber

The Soviet light, transonic bomber which carries the NATO designation of *Backfin* is in flight test. The swept-wing *Backfin* achieves a speed of 1,000 miles an hour at an altitude of 35,000 feet. It is powered by two jet engines of 15,000 pounds thrust each mounted in the fuselage of the aircraft, with the engine air intakes located above and to the rear of the cockpit.—News item.

Light bomber *Backfin*

Rocket Bases

A network of Soviet missile-launching bases from Rügen Island on the Baltic coast of East Germany and Kaliningrad in East Prussia and extending a thousand miles to the southeast has been reported. Two bases are in Romania, two in East Germany, three in Bulgaria, one in Hungary, five in Czechoslovakia, and one near the Baltic Sea resort town of Kolobrzeg in Poland. The rocket base near Kaliningrad (formerly Koenigsberg) in East Prussia is said to be manned by the 1st and 3d Soviet Guided Missile Divisions. According to a West German bulletin, atomic warheads for the weapons are stored in the same region. Missiles available at this base are said to be the *T-3*, *T-4*, *J-2*, and *Comet II* (MR, Apr 1958, p 72). Other bases are reported to have the Soviet two-stage *T-2* intermediate range ballistic missile.—News item.

Nuclear Weapons Tests

Nuclear weapons tests conducted by the USSR in the eight months preceding the 31 March 1958 Soviet suggestion for suspension of nuclear tests were as follows:

Date of Test	*Range of Yield*
22 August 1957	Substantial size
7-9 September 1957	Moderate intensity
24 September 1957	Megaton range
10 October 1957	Small
28 December 1957	?
23 February 1958	Megaton range
27 February 1958 (2 tests)	Megaton range
14 March 1958 (2 tests)	Below megaton range
15 March 1958	Below megaton range
20 March 1958	Small
21 March 1958	Larger than that of 20 March
22 March 1958	Medium range

YUGOSLAVIA

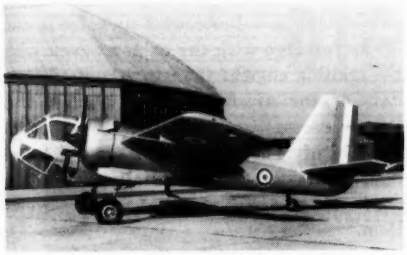
Underground Arms Factory

A huge subterranean factory for the manufacture of nuclear rockets and remote-controlled tanks is reported to be under construction by the Soviets in the Bosnia area of north central Yugoslavia.—News item.

FRANCE

Support Plane Tested

A prototype of the two-engine overseas support plane *SIPA.1100* has carried out initial test flights successfully. The *1100* is designed as a simple, rugged, general-purpose aircraft for operation from small



Support plane *SIPA.1100*

unprepared airstrips. Constructed as either a two- or a three-seat plane, it is powered by two 600-horsepower *R.1340* engines and weighs about six tons fully loaded. The cockpit of the *1100* is designed to give exceptionally good visibility. Details of the military version of this aircraft have not been released.—Official release.

Interceptors Tested

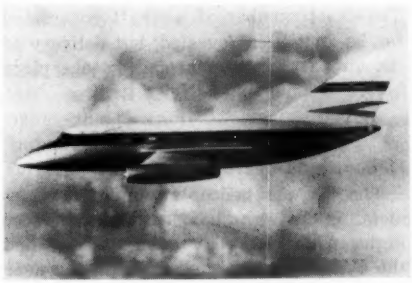
The *Mirage III* interceptor has been successfully flown in a preseries version, and the *Etendard IV M*, intended for the French naval air forces, is in an advanced stage of development. The *Mirage III*, reported to be capable of a speed of Mach 2 in level flight, is a delta-wing, all-weather interceptor with outstanding low-speed characteristics which permit its use from short, makeshift runways. It is powered by an *Atar 9* engine having a thrust of six tons with afterburner, and is equipped also with an auxiliary rocket giving an additional thrust of 3,300 pounds. It is provided with long-range detection and firing radar equipment, and armed with two 30-mm cannons and underwing mounts for bombs and rockets. The *Etendard IV M* is a modification of the *Etendard IV* prototype. It is equipped with an arrester hook, folding wings, and catapult gear. It also has the "coke bottle" fuselage configuration and a more powerful engine than previous versions.—Official release.

Additions to Fleet

Two radar picket escorts of the *Duperré* class, the *Forbin* and the *Tartu*, have entered active service. These 3,750-ton vessels have a top speed of 34 knots, and are fitted specially as aircraft direction and command ships. Their hulls are entirely welded, and light alloys have been used extensively in their superstructures. In addition to conventional antisubmarine weapons, they are equipped with a new heavy six-barrel hedgehog antisubmarine mortar.—News item.

Executive Aircraft

The most recent in the line of Dassault aircraft is the executive plane, *Méditerranée*, which is now under construction,



French Embassy Press and Information Division Photograph

Dassault *Méditerranée*

and which is expected to be in flight test by the end of 1958. It will carry eight passengers at a speed of about 550 miles an hour.—News item.

EGYPT

Increase Submarine Fleet

Three more submarines have been added to the Egyptian Fleet. The new submersibles, purchased from Poland, are manned by crews from the United Arab Republic who were trained at Polish North Sea bases. The arrival of the vessels makes six submarines that have been added to the Egyptian Fleet from Communist sources during the past year (MR, Oct 1957, p 67). It also has been announced that Egypt has purchased an undisclosed number of *Tu-104* transport aircraft (MR, Jul 1956, p 71) from the USSR. Reports indicate that pilots for these aircraft are being trained in the Soviet Union.—News item.

INDONESIA

Arms Purchase

Indonesian pilots are being trained in Egypt in the operation of Polish and Czechoslovakian manufactured fighter and bomber aircraft. The training program is part of an arrangement wherein Indonesia is buying *MiG* fighters from Czechoslovakia and *Ilyushin* bombers from Poland. The exact number of aircraft contracted for has not been revealed, but delivery of the aircraft is not expected to take place before next spring.—News item.

NATIONALIST CHINA

Helicopter Developed

The *CJC-3A* helicopter, under development on Taiwan, has accomplished free flight. An improved version, to be called the *CJC-3B*, is expected to fly in the near future. The tandem rotor *CJC-3A* carries a useful load of 550 pounds and has a maximum speed of 112 miles an hour. It can carry one passenger in addition to the pilot, and has a range of 145 miles. The two 24-foot rotors of the aircraft are driven by a 190-horsepower engine.—News item.

ITALY

Mixed Power Aircraft

The Aerfer *Ariete* is a developed version of the *Sagittario II* (MR, Apr 1957, p 68). It features a 1,860-pound thrust *Soar R.Sr.2* short-life turbojet engine in a tail mounting with a retractable air intake located behind the cockpit. The main powerplant is a *Derwent 9* turbojet in the lower fuselage with the exhaust even with the trailing edge of the wing. Performance data on the *Ariete* are not available, but its predecessor, the *Sagittario II*, was capable of speeds of about 650 miles an hour, and was the first Italian-built aircraft to exceed the speed of sound.—News item.

JAPAN

Submarine Construction

The 1,000-ton *Oyashio*, the first submarine to be constructed in Japanese shipyards since World War II (MR, Mar 1958, p 73), is described as a training vessel. The vessel will have a top submerged speed of 19 knots, a surface speed of 23 knots, and an endurance of 5,000 miles. Its armament will consist of four 50-cm torpedo tubes and it will be able to carry 10 torpedoes. A second submersible of this type is planned.—News item.

SWEDEN

Civil Defense Plans

Sweden has sufficient underground shelters to provide protection for two million citizens from atomic attack. These range in size from small subterranean units in rural areas to a great shelter in a mountain at Vasteras, and a 20,000-man shelter directly under the capital city of Stockholm. The main Stockholm shelter, called *Katerina*, is 120 feet underground. Other shelters, each accommodating 1,000 persons, are to be built under the main stations of the city's subway system, now under construction.—News item.

FOREIGN MILITARY DIGESTS

Operations Research

Translated and digested by the MILITARY REVIEW from a copyrighted article by Major J Barbier in "Revue de Défense Nationale" (France) October 1957.

During the course of the last World War the idea developed of applying scientific research not only to the creation of weapons of war but also to the operations themselves—that is, to the actions and decisions of the men charged with the conduct of the ponderous military machine. The activity of groups of scientists, charged with studies whose object was to increase the efficacy of the means put into action in certain military operations, was at that time designated by the British term, "operational research," or the American term, "operations research."

The French equivalent, *recherche opérationnelle*, is not very satisfacotry but has been established by usage. Even if the term is of recent origin, the idea of having recourse to scientists for the solution to military problems is a very old one.

When Syracuse was besieged Hiero consulted Archimedes whose intervention was to make resistance possible by setting fire to the enemy fleet by the use of mirrors.

Possibly the Trojan horse also was due to the inventive genius of operational researchers of the time. Napoleon himself made use of technical advisors.

Clausewitz is cited as an example of the operational researcher by P. M. S. Blackett of Great Britain. In order to translate into military terms the advantage given by a superior general, Clausewitz analyzed all the battles of Napoleon, drawing up a table of the relative sizes of the opposed armies, their successes, and their failures. Thus he arrived at the conclusion that even the best general imaginable, even if he were as great as Napoleon, could not win a battle if his forces were inferior to half those of his adversary. The difference between a mediocre general and a genius thus could be expressed, numerically, by the factor of two.

However, it was between 1937 and 1939 that the term "operational research" came into use for describing the activity of a small section of the research station of the British Air Ministry. Different types of radars were under study at that time in this establishment. The word "operational" was quite indicative of the activi-

ties of this section whose work had to do with the utilization, in the broadest sense, of radar installations considered as part of the over-all air defense system. The resounding successes afterward obtained during the course of the war by operations research—in the domain of aviation and the naval forces in particular—brought into evidence the great value of this new scientific activity. After the conclusion of hostilities it was extended from the purely military to the civil field. Since there no longer was any doubt concerning its efficacy, it continued to be developed in this latter domain.

One may, therefore, wonder why it has been necessary to wait these last 20 years for this activity to assume such importance that a special term has had to be coined to characterize it.

Fundamental Factors

First, there was a very distinct awareness of the difference between the efforts devoted to technical progress—where nothing was spared for improving existing weapons or for creating new ones—and the almost nonexistent efforts made toward realizing the best possible use of these weapons.

Second, the tempo of thought becomes relatively much slower than that of action. Due to technical advances, operations take place at a continually increasing speed. It becomes necessary, therefore, to improvise decisions which cannot but lag behind the development of operations.

To be convinced of this, and taking present speeds into account, it suffices to consider the problem of the interception of bombers or enemy missiles by interceptor aircraft or missiles. To a greater degree than ever it is indispensable to think before acting.

Finally, if the factor "speed" is able to explain in part the importance of operations research, "complexity" plays no less important a role.

Complexity

There no longer is any common measure between the mass and the speed of the forces put into action in a major operation and the power of conception and decision of a single human brain, no matter how unusual. Both in the civil and the military domains the majority of the problems present so complex an aspect that the correct decision is not immediately obvious, and several decisions may appear equally good.

One may, then, resort to empirism or the more or less risky extrapolation of experience. If the point of departure is incorrect, however, or if the extrapolation is conducted wrongly, it is easy to see into what errors one could fall.

One of the determining factors back of the establishment of operations research and its rapid growth is the growing complexity of the problems of the modern era. Thus the chief of a civil enterprise or the military chief is provided with scientifically studied data enabling him to make a decision by foreseeing what will result.

But if operations research was born from the need for the scientific preparation of decisions, reducing it to a mere instrument would be to limit it strangely.

Definitions

Dr. Charles Kittel of the Bell Telephone Laboratories has stated:

Operations research is a scientific method for providing responsible leaders with mathematically established bases for their decisions.

This definition may be compared with that of Mr. Ellis H. Johnson, Director of the Operations Research Office at Johns Hopkins University:

Operations research is the prediction and the comparison of the value, the efficacy, and the cost of a series of possible specific actions putting into play systems composed of men and machines with the view

to the attainment of given objectives. To this end it makes use of an action model which has been determined by logical analysis and, when possible, by mathematical methods.

This last definition would indicate that operations research can exist without the necessity of an immediate decision. According to Ventura:

It aims, first of all, at the facts relative to a situation with the view of afterward deducing from them rational principles of action which take the place of empirical recipes.

Certain studies, such as that of P. Massé on "Reserves and Regulation of the Future in Economic Life," confirm the idea that operations research embraces an infinitely wider field than that of the simple application of scientific method to the preparation of decisions.

The first studies of operations research did, in truth, have as their objective the direct solution of practical problems. The brilliant successes obtained at that time by certain methods or techniques contributed strongly to veiling, in many minds, the true nature of this new scientific activity. They were the trees that hid the forest.

Errors in Approach

The different theories or methods—theory of lines of expectation, method of Monte Carlo, theory of games, linear programmation—have a clearly defined and necessarily limited field of application. Contrary to this, in the present state of our knowledge the limits of operations research cannot be fixed.

It appears to be an experimental science whose aim is to ensure the active direction of future operations (where operation may be defined as the repetitive action of a group). A battalion engaged in combat, a squadron of planes fulfilling a mission, a factory in operation, or a commercial organization are more than an assemblage of men and machines; they are an activity, a type of operation.

Operations research must attack problems which are complex by nature, making use of techniques and methods which essentially are its instruments. The operations researcher finds himself harassed in his work by definite illusions and dangers. In "Fallacies in Operations Research," a study presented on 10 May 1956 at the fourth Annual Convention of the "Operations Research Society of America," B. O. Koopman spoke of four principal errors which he designated as: linearitis, maximitis, mechanitis, and authoritis.

The first error (linearitis) resides in the affirmation that every problem can be reduced to an ensemble of linear functions, the relationship between the different phenomena being set down in the form of rules of proportion. One thus is led to an overevaluation of linear programmation.

The second (maximitis) consists in the assurance that the most probable will happen. Since the mean often is confounded with the most probable value, one easily arrives at the belief in the virtual certainty of the mean.

The third (mechanitis) corresponds to the state of mind of the individual who is so impressed by modern calculating machines that he believes that a mathematical problem which he cannot solve or even formulate automatically will find its answer as soon as he is able to have at his command a sufficiently perfected and costly machine. Of this error Dr. H. Thomas (of IBM) is said to have stated: "Proof of the correctness of certain methods of machine calculation requires such a high degree of knowledge that a direct mathematical attack would be easier." "Monte Carloism" is a particular case of this error, as well as the notion that a "war game" can serve for establish-

ing the chances of success of different tactics.

"Authoritis" consists in believing that the responsible chief who must make use of the result can find the missing links of the solution—that he can couple the theoretical problem with the practical realities which the problem attempts to express and solve.

Variables

The origin of these errors resides in the fact that, in contrast with mathematical sciences, operations research makes use of criteria, interposing conceptacle values with all their human and practical implications. The example of the submarine war permits our grasping the importance of the choice of a "typical parameter." If we consider the offensive employment of the antisubmarine forces, the typical parameter will be the number of enemy submarines sunk. On the contrary, if we consider a purely defensive aspect, the parameter will be the probability of the enemy submarines passing through the screen protecting a convoy.

The current tendency to utilize money (that is, the cost of this or that operation) as a criterion, is not always justified. There is no factor of equivalence between money and victory any more than between money and human life.

One thus perceives one of the basic difficulties of operations research: the choice of the variables to be studied.

In fact, even if the problem is well-formulated, the choice of criteria lies at the heart of the matter. In the final analysis the success or the failure of the study and of its termination in a useful solution will depend on this choice. B. O. Koopman distinguishes four phases in every complete development of operations research:

1. Choice of the "figures of merit" (basic data, typical parameters).

2. Choice of the "indices of effort" (variables indicative of efficacy).

3. Establishment of a more or less precise model.

4. Search for the optimum.

According to him the first two phases are the most difficult for it is necessary to find the basic variables of the problem in order to reduce the phenomenon to a simple and precise formula. This also is the opinion of Charles Hitch of the Rand Corporation. The choice of criteria appears particularly difficult since there exist no theoretical bases for guidance.

Operations research is in its beginnings, and the development of every scientific theory naturally is slow and difficult. Total ignorance does not exist, however.

Criteria

Mr. Hitch has stated, "We do not know how to choose the best criteria but we know enough, in many cases, to distinguish between good and bad ones." It is necessary, therefore, to seek the means for choosing the *criteria* and to learn what characteristics they must possess to be of value.

Mr. Hitch has further explained, "Operations research will be improved enormously if we give more attention to criteria than to models or to techniques of calculation. In the end we shall choose them rationally." The same idea appears again over the signature of Mr. Guilbaud, "Everything that has succeeded must be gathered together (also all that has spelled failure which sometimes is even more instructive) to be analyzed patiently and put together again in an *ad hoc* proceeding out of which a scientific doctrine as intelligible as possible will emerge." It is this scientific doctrine which must be the distant objective, and in order to achieve it, it is necessary to guard against two tendencies.

The one limits operations research to being only an instrument of decision. To be sure, one would arrive thus in many cases at brilliant decisions, but without

any connections being evident between them.

The other tendency, on the contrary, sees in operations research nothing but intellectual speculation whose practiced results are entirely questionable.

These two tendencies reflect only one of the aspects of operations research, neglecting the others, and it must not be forgotten that in a scientific ensemble there is both theory and its practical applications. It is for this reason that pure mathematics opens to the engineer numerous paths leading to practical realizations (the strength of materials, aerodynamics, and hydrodynamics).

Command

Command is interested directly in practical applications and their results. If one fails to develop a solid theoretical basis, one is condemned to only limited possibilities.

Operations research—which may be regarded as the study of the "dynamism" of situations, procedures, organizations, or of methods—must have at its disposal a sufficiently broad and varied scientific apparatus.

On this condition, and by combining the profound theoretical study of the operation with extremely practical observations, it will be possible to provide the chief with precise information and useful principles for aiding him in making decisions. But the fact must be stressed that operations research makes no pretense of taking the place of his judgment. In all cases responsibility for the decision rests with the command.

Close collaboration, therefore, is indispensable. The chief is not to disdain this aid which science brings to him but must make the best possible use of it. The researcher must develop the theoretical bases which will permit a perfection of the most suitable techniques and methods for the study of the most complex problems.

In the vast field of military activities, operations research must give effective assistance to command, whether the problem is to determine the efficacy of weapons and equipment, to analyze the results of operations, to study the reciprocal influence of weapons and tactics, or to establish the comparative value of different organizations or methods.

But one must beware of the illusion that research can easily and rapidly determine a solution for every problem.

The first difficulty—which was so well-illustrated by the words of Foch: *"De quoi s'agit-il?"*—is to formulate the problem well and to find criteria whose interaction characterizes the phenomenon under study.

This first difficulty solved, it most often will be necessary to resort to the most perfected and the most powerful techniques of mathematics (statistical tables and the theory of probabilities) which impart to operations research much of its power and fertility.

And last, it will be necessary to translate the results of a scientific task into elements of decision which can be utilized by the command. The experiences of the last conflict demonstrated the great value of this application of scientific method to matters of a military nature.

Conditions of Success

In order for continued practical results to obtain, two conditions seem essential.

1. The distant objective to build up a well-balanced doctrinal structure whose keystone appears to be the rational choice of criteria must be kept in mind. All study of any particular problem must not only furnish the practical solution that is its immediate objective, but also supply a stone for the building up of theoretical doctrine.

2. A trustful exchange of ideas must be established between researchers and executors. It is incumbent on the executors to

formulate the problems presented as clearly as possible, giving the researchers all the data and information on the subject under consideration. It is incumbent on the command also to give proof of patience if the researchers fall sometimes into impasses before arriving at final success. It is the task of the researchers to labor without fear of the failures that frequently occur and in spite of the lack of understanding they may meet.

From this fertile collaboration must be born the solution of problems which heretofore could never be attacked in their ensemble.

Operations research is sufficiently rich in promises for no doubts to exist concerning its future.

Norway's National Guard

Digested by the MILITARY REVIEW from a copyrighted article by Frank Sheer * in the "Canadian Army Journal" January 1958.

Most of them were wearing German helmets, but their guns were a strange mixture of English, Swedish, American, and German makes. Their uniforms were United States-style fatigues with a shoulder-flash with the initials *HV* and a crown, embraced by oak leaves.

They seemed to shoot up like mushrooms on the lonely mountain highway

A firing position on a hand-drawn sled

in central Norway, and it was obvious that they meant business. The platoon leader, a young-looking man, pointed to his men who were well-camouflaged and lying in position on both sides of the road.

"We are National Guardsmen just having a routine exercise. Sorry to have to stop you, sir—regulations, you know." His English was close to perfect, with an Oxford accent. A second look at his battle-dress revealed two rows of service ribbons indicating a varied experience with the Allied forces. We were waved on.

Any visitor to Norway is likely to encounter such a scene sooner or later, whether he is driving on a mountain highway or just taking a Sunday afternoon stroll in Nordmarka, the hills surrounding Oslo, the capital. Security conscious, however, they will tell very little about themselves, and only after going through the proper channels is it possible to piece together the remarkable story of the Norwegian National Guard.

When the last war ended in 1945, Norway was taken over by combined allied forces including foreign-trained Norwegian units from Sweden and the United Kingdom, together with the 45,000-man resistance movement, clandestinely trained by paradropped Norwegian and allied instructors. A quick glance at the existing defense forces was far from encouraging despite the fact that a sizable number of Norwegians had received training as well as actual combat experience during the war years.

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"The national defense has a broken back" was the term used by Jens Christian Hauge, then Minister of National Defense, a former leader of the resistance movement in his early thirties. And a broken back indeed it was. The 450,000 German Wehrmacht soldiers who were in Norway on V-E Day had left huge military supplies, but the planning of the

As Supreme Allied Commander in Europe, General Eisenhower often inspected the Norwegian National Guard

postwar defense, nevertheless, had to start from scratch.

By 1946 a three-year plan for the establishment of the national defense forces was submitted to the *Storting* (Parliament) and approved unanimously with very few alternations. The outlook for peace was bright, and quality was stressed above quantity. New ideas based on actual war experiences were introduced. Most revolutionary was the establishment of a National Guard, *Heimevernet*, later to be known and respected by the initials *HV*.

The original plans called for 30,000 conscripts as well as an additional 10,000 volunteers. Any man between 17 and 65, physically fit and with a clean wartime record, was free to join. Plans were made to give these men training during their spare time and on holidays with a minimum of 50 hours per year. Without extensive military traditions in modern times, many Norwegians thought the entire idea impractical, and predicted a meager response to the call for volunteers. The general opinion was that the people had had enough of uniforms and the army in the five years of German occupation.

The development proved otherwise. More than 70,000 volunteers applied before a single cent was spent on recruiting or advertising.

"Only free men have the right to carry arms and defend themselves," said General Helseth, and to prove that they were really free they rallied. It was a big surprise to many of the military authorities.

To the few who had fought the idea through, this was no surprise. Today, they explain it as the natural reaction of a generation which had seen the country

National Guard underground depot

attacked overnight by foreign forces, and had taken up resistance without adequate preparations or equipment. Six weeks of continuous unequal battle, against overwhelming German invasion armies following the sneak attack of 9 April 1940, resulted in a healthy preparedness complex formulated in the slogan adopted by the National Guard, "No more April 9ths."

So fast did the organization mushroom

that basic needs were lacking for a long period of time. In the beginning, the guardsmen wore civilian clothes with an armband. Weapons were mainly leftovers from the Germans. Training facilities and experienced instructors were needed badly; also needed, to a certain extent, was high-level support. Initially, the guardsmen were apt to hear themselves nicknamed "Sunday soldiers" or toy soldiers. Some call, provide adequate training facilities and equipment, and to get the attention of the military and civilian leaders.

When the Communist purge in Czechoslovakia in 1948 emphasized the importance of the National Guard, the organization was well-established. As the entire plan for the defense buildup was revised and speeded up, the National Guard received its share of the appropriations and,

Training at the Officers' Training School at Dombaas is realistic

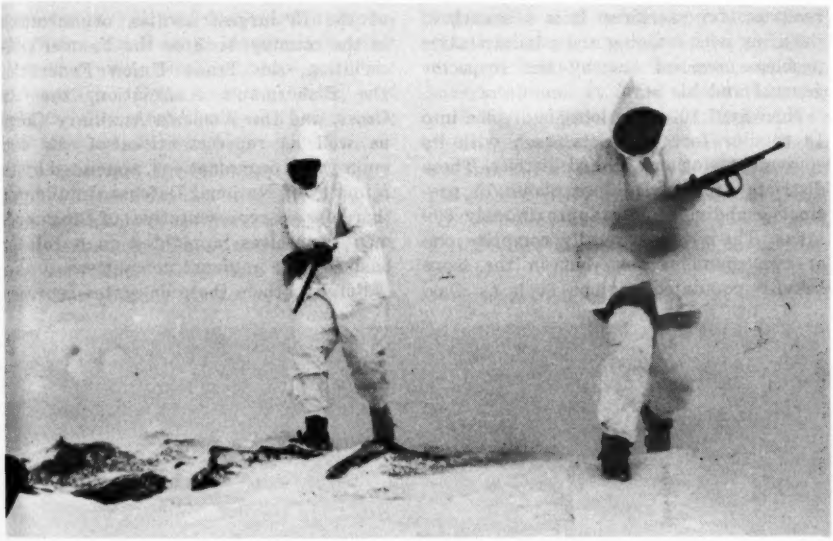
senior officers expressed their fears that accidents would result from the policy of allowing the guardsmen to keep their own small arms at home.

But at the top was a man of vigor, Major General (then colonel) Mons Haukeland, who had fought the Germans in 1940. Slowly he built the organization. He was aided by a competent staff of officers and noncommissioned officers who had spent the war years as paratroopers, intelligence agents, and commandos.

It was in many ways an uphill fight to maintain the enormous response to the perhaps even more important, had been recognized by the people.

Major General Haukeland, now the inspector general, heads his staff in a former German barracks in the heart of Oslo. A never-tiring personality who now is past 65, he always has time for reporters and writers, stressing that public relations is of vital importance to such an organization as his.

The secret of the National Guard's success lies in its relations and direct contact with the people, which are essential to any organization built on good will and



All men participating in training during Operation *Igloo* are volunteers. Above, guardsmen advancing during the operation. Below, men on realistic training maneuvers

readiness for sacrifices. It is a branch of the army with training and administrative problems worked out by the inspector general and his staff.

Norway, 1,100 miles long, is divided into 18 regular force districts, each with its equivalent National Guard district. These districts are divided into about 75 precincts, subdivided into approximately 600 areas. The areas generally comprise one or two municipalities, but in the more heavily populated regions such as Oslo

Dog teams provide necessary transport during an exercise

several areas are in existence. The greater number of officers are only "part-time" soldiers, working under tremendous strain with a dual responsibility of holding down their civilian jobs as well as administering the area. It also is notable that there is less than one professional officer or noncommissioned officer for every 600 men, and that officers and noncommissioned officers on the platoon level do not receive any form of pay or allowances for their rank.

The National Guard Council is made up of the 12 largest civilian organizations in the country, such as the Farmer's Association, the Trade Union Federation, the Fisherman's Association, the Red Cross, and the Women's Auxiliary Corps, as well as representatives of the four main youth organizations, appointed by the Ministry of National Defense. In addition, there are six representatives of the guardsmen themselves, appointed on a rotation basis by the regional committees.

Between them these delegates represent practically every walk of life in Norway. They work out policy, and make contributions to equipment and activities not necessarily within the framework of the Department of National Defense. Certain matters of disciplinary character are handled by the councils, but discipline technically is the same as for the regular armed forces.

The inspector general sums up the main tasks of the guard with these words:

The prime objective is to keep a con-

stant watch. The guardsmen will also provide information about the enemy in time of war, provide security forces until the mobilization of the regular forces, and fight the enemy together with these forces, once they are organized.

For a country like Norway, with a population of less than 3.5 millions, it is almost impossible to maintain a large standing defense force. The conscription system provides almost four field divisions, a small but efficient air force, and a navy and coastal artillery. As a country bordering the Soviet Union, Norway's obligations to NATO, which it joined when the defense community was formed, calls for an alert watch and every-ready prepardness. With the air force, the National Guard shares the main responsibility for this.

Every man keeps his uniforms, small arms, radio sets, bazookas, and other equipment at his home, and is ready to take up the fight at any time. As a result of repeated nationwide exercises, the time required to man bridges, power stations, railroads, airports, army depots, and other strategic installations has been cut to a bare minimum. It is no secret that this probably is Major General Haukeland's greatest pride—that within an hour from the time the alert is sounded, thousands of guardsmen will be on the spot, and that six divisions, or a total of 75,000 men, divided into small units will be in their positions within two to four hours. It is obvious even to strangers that this is of the greatest importance in a country where distance between the two "standing brigades" is equal to that between southern Norway and Italy.

Helicopters and weasels are used for mobile forces

Once in their positions, the National Guard has a great advantage over a potential enemy in their intimate knowledge of every hedge, creek, housecorner, and manhole in their areas. Over and over again they train to counteract every possible enemy approach to their defense objectives.

The guard has several training establishments—mostly in rugged, mountainous terrain—where short intensive courses stress subjects such as street fighting and sabotage. Lately a plan has been drawn up under which all physically fit members will have to undergo a course in guerrilla warfare. Many of the instructors are former saboteurs and guerrilla fighters who fought in these same mountains during the war.

Laplander guardsmen in "mufti"

The individual guardsman also takes a particular pride in his knowledge of his own area. In some areas they have perfected the art of guerrilla warfare to the point where practically nothing seems impossible for them.

During a recent joint exercise with units of the British Royal Marines on the Norwegian West Coast, the marines, after a successful landing operation, set up camp for the night. Sentries were posted all over the area, and the war-experienced upper crust of the British armed forces felt confident that they had a good night's rest ahead of them. Their sense of security was increased when they woke up in the morning without having been disturbed all night—until they discovered that the guardsmen during the night had passed the sentries and marked every single item they had with chalk-marks, indicating that they would have been exterminated in the event of a real war.

Although the National Guard technically is more or less part of the army, only half the force is earmarked for army operations. Of the balance, 30 percent are trained as antiaircraft crews and air defense units, and the remaining 20 percent man the coastal artillery or make up the

National Guard "Navy"—small fishing vessels manned by experienced fishermen and trained by naval officers.

In the defense budget, totaling more than 920 million kroner (128.8 million dollars) some 21 million are allocated to the National Guard. Many of the men, including draftees, go to great expense to improve their areas, supply additional equipment, and motor transportation.

Through the cooperation of the civilian organizations represented in the council, the guardsmen have built or acquired more than 200 *HV* houses, containing rooms for indoor training, stores, and offices. Many of the members have put in long additional hours in the actual construction of these buildings over and above the required minimum of hours set aside for training purposes.

A Royal Decree of 10 June 1949, apparently inspired by the Communist *coup d'etat* in Czechoslovakia and the country's own bitter experiences from 1940, states clearly:

Any armed attack on this country calls for full mobilization, no matter what contrasting orders might be issued in the name of the King or the Government. They [the members of the armed forces] must resist, though left alone, regardless of whether the enemy threatens or actually carries out reprisals [by bombing towns or similar actions].

In order to carry on the vital economic life of the country, the guardsman is supposed to go back to his daily work as soon as the regular forces are mobilized in his district. He wears his uniform and carries his weapons with him. In case of direct enemy actions in his area, he fights until the district is occupied. He then is to engage in guerrilla activities or make his way to the regular forces outside the occupied territory.

From the south, all the way up to the Russian border, away inside the Arctic Circle, Norwegian Guardsmen are ready to fight at a moment's notice—bank clerks and businessmen, workers and fishermen, rural and urban. They reach their secret assembly points on foot or skis, by car or on bicycles.

In the far north the picturesque Laplanders in their heavy reindeer coats and colored parkas patrol the endless snow-plateau in their small sledges, called *pulks*, drawn by reindeer.

As one guardsman put it when I asked him why he spent so much of his time in the National Guard:

At least we'll be prepared. It just isn't enough to pour in arms from overseas in this country. It will be the few hours that will be deciding the outcome of a campaign. And you bet, we'll make a fight for it. So, we want to know how to fight. April 9th won't happen again.

Rearmament Requires New Concepts

Translated and digested by the MILITARY REVIEW from a copyrighted article by Friedrich Wirth in "Wehrtechnische Monatshefte" (Germany) April 1957.

Technical progress in the development of weapons has created new weapons that demand new relations between man and matériel. However, these relations and their consequences are not yet completely understood. Under certain conditions a reduction of manpower may be possible, but the atomic weapon will not replace the different weapons of the services. The task area is entirely different.

The atomic weapon destroys everything within its range. Under certain circum-

stances it can open the way for the infantry troops waiting to attack. It is interesting to compare this with conditions in the Monte Cassino battle in World War II where destruction by the Allies helped the Germans to build centers of resistance which impeded attacking Allied tanks.

The atomic weapon also is able to destroy insufficiently protected enemy troop concentrations and may disturb enemy artillery positions and communications. But alone it cannot take nor hold a combat area.

Infantry still remains queen of the battlefield, and other traditional weapons also retain their importance. For example, without sufficient infantry it will be impossible to exploit after the enemy has been weakened by atomic fire.

The effects of energy resulting from nuclear fission or fusion are known. They depend upon the charge, the material of the bomb, the altitude at the time of explosion, and the target area. They decrease with the increase of distance from the explosion center. It is possible, however, to find zones of no effect within the explosion area.

Within a few seconds after the explosion a shock wave has destroyed more or less everything that was above surface level. Heat radiation (0-3 seconds after the explosion) and gamma rays (0-40 seconds after the explosion) are dangerous for the unprotected person.

Man also may come under the effects of residual radiation, for near the crater (or near ground zero) a strong radioactivity is present. The influence of radiation in an area depends upon the length of time spent in the affected area, the strength of radiation that decreases in time, and eventual measures for protection.

Protective measures against effects of atomic weapons are known. They are difficult to realize, however, within a frame of economic and military possibilities. But the probability of the employment of atomic weapons demands that use be made of these protective measures to the extent practicable.

Not only bombs and missiles but also artillery projectiles of different caliber can employ atomic attack weapons, and remote-controlled planes (for example, the *B-61 Matador*) have to be considered. Typical of this development is the enormous increase of range for heavy bombers.

US Air Force Photograph
TM-61B Matador

For this reason most nations seek to create a forefield as great as possible in order to have sufficient early warning from advanced radar stations. Within range of the farthest advanced missile stations, however, the warning system probably will be useless.

The forefield is an area vaguely defined by the warpower and political situation of countries. Both of the two power blocs today are attempting to open, increase, and

defend their forefields with all means by treaties, economic aid, and military support.

The Shape of War

We will have to expect that in the first hours of another world war remote-controlled missiles and long-distance bombers will have started their attacks against specified and known targets. These will be, among others, important train junctions, supply centers, bridges, dams, and all types of military positions and concentration areas. It will be important to cripple the supply, communications, and mobility of the enemy.

At the same time, tank divisions and mobile infantry troops will attack. Their progress will depend upon the resistance of the enemy, the size and condition of roads and river crossings, and their supply. Partisans may play an important role. Each of the warring countries will try to carry the combat into enemy territory, or at least to the border territory, in order to spare their own country the inevitable devastations of atomic battlefields.

Whether it is advisable to protect the borders by a static defense or by mobile combat units still is an open question. At first, the installation of mobile combat units will be favored. The static defense is more expensive and demands more men; such positions can be bypassed or taken by encirclement by airborne troops. They offer, however, a certain protection against atomic weapons and can be built in peacetime at locations favorable for defense.

Aggressors have a tendency toward preventive wars and will have initial successes which force withdrawals. In this case, a Pusan type position to be supplied by sea always is comforting for the fighting soldier. It also may serve as a base for later counterattacks, but has to be planned and built during peacetime to ensure the wartime availability of an independent defense position which is safe against atomic attack.

Great movements of troops will be difficult or impossible. This may lead to the requirement that defense forces go into prepared defense positions when danger of war is imminent without regard to the eventual direction of attack of the enemy.

A prepared position may be natural, artificially reinforced, or a static position with all-around defense. In addition to their defensive force, it would be useful if they could form a suitable lie-out position for counterattacks—then the enemy could not bypass such a position.

Supply will be difficult or impossible. Many persons will suffer wounds, burns, and radiation sickness. More or less strongly affected areas of all sizes may be hit and infested by radioactivity. All surface constructions within range of the atomic shock wave will be destroyed. Extensive fires can be expected.

Protective Actions

If we accept the possibility of a situation such as described above—drawn from experience (Japan), war plans, maneuvers, and the war potential of both powers—the following actions are necessary:

1. Creation of a far-advanced radio warning service in a safe forefield.

2. Creation of a civil air defense (evacuation, safety zones, first aid, treatment of radioactive sickness, additional hospitals, casualty evacuation, and industrial air defense).

3. Preparation for defense against attack by supersonic aircraft by use of remote-controlled missiles (*Nike*), and for atomic antiaircraft defense.

4. A reduction of sensitivity to air attacks by construction of steel and concrete buildings, subterranean shelters and installations, camouflage, and dummy targets.

5. Securing of airports by installation of air safety services in atom-safe shel-

ters; securing of fuel dumps; and revetted and camouflaged storage for planes.

6. Installation of a radiological service for designation of radioactive infested areas.

7. Destroying advanced missile-launching bases of the enemy.

8. Institution of local armed forces to help in casualty evacuation, antitank defense, and demolitions. Protection of vital installations against sabotage and paratroopers.

Organization

Because of new weapons, attention must be directed toward the formation, structure, equipment, training, and employment of frontline units. The cohesion, structure, training, equipment, and leadership of the troops will be decisive.

Rearmament is based upon the demand for increased firepower of the combat unit and great mobility. It is possible to increase the firepower partly with tactical atomic weapons, assault guns and missiles, and a long-range antitank defense.

Mobility is to be increased by motorization in spite of the fact that it may cause problems of supply. Freedom of movement is important to even the lowest ranks because demands for quick, often independent action are created by the new weapons. But no matter what structure of forces is created, the infantry cannot be weakened.

Training

During the training of the forces, disciplined orientation on the effects of the new weapons and combat methods must be stressed in order to assure prompt action in protective measures.

The unit must be especially trained in night operations.

The reaction of troops surprised by an atomic explosion is of considerable importance. Cover must be sought at once—eyes and face have to be protected by turning the back toward the fireball and lying flat on the ground. Action during the first 20 seconds is most decisive.

In concentration areas and other preparations for attack or defense the troops will go to earth in order to be protected against the effects of atomic weapons. Since both parties will observe a certain safety distance for the protection of their own troops, as in the case of chemical gas warfare, more safety will be found in the frontlines than in the assembly areas. The direction of the wind has to be observed to avoid fallout. If this is not possible, the gas mask has to be used to prevent the soldiers from breathing those particles. After going through such a cloud, man and equipment are to be cleaned carefully.

A radioactive area can be crossed without delay if tactics should require it. The crew of an armored car is better protected against the effects of radioactive weapons than the foot soldier, but as these cars usually are not airproof the crew also has to wear respirators.

Because of the possibility of an atomic attack even before war is declared, all combat units must be continually ready for action. They have to protect themselves and their machinery against the shock wave. That is why the battleships left the United States in the critical days of the fall of 1956, and the long-distance bombers left their bases. As far as weapons are mobile, one tries to avoid massing targets.

Future maneuvers for battle may not start from safe barracks but from distant camouflaged and protected camps or from fixed emplacements half or altogether below the surface of the ground. For this reason the Maginot Line finds new meaning with its tremendous subterranean installations which offer protection for the soldier of the atomic age. That applies as well to the great Czechoslovakian permanent emplacements which also offer sufficient space for troops and equipment.

An example of this is the "Berghöhe" near Grülich.

Conclusion

The dawn of the atomic age, where atomic energy will be employed on the battlefield, forces us to a revision of our mental attitude toward war and our efforts to retain peace and freedom. It is necessary to discuss the eventual dangers of atomic warfare because this is the only way to prepare protective measures. After all, we have to consider that both major powers will make use of the new weapons in case of war.

The probable employment of atomic weapons has forced us to take their devastating power for granted from the very beginning. We do not know how long a worldwide war will last, but each of the power blocs must keep his war potential up, for without it a war soon would exhaust the nation.

The Pattern of Responsibility

Digested by the MILITARY REVIEW from a copyrighted article by Major Reginald Hargreaves in "The Army Quarterly" (Great Britain) October 1957.

IN THE American Colonies' struggle for independence the crucial year was that of 1777.

With George Washington's appointment to command the improvised "forces of freedom," the only British troops in the field —the garrison in Boston—raised the siege of that city by the simple, if humiliating, process of evacuating their lines and taking ship to Halifax, Nova Scotia.

Within a year, however, General Sir William Howe had staged a successful comeback by soundly trouncing his opponents at the Battle of Long Island where the battered colonial survivors only just managed to disengage and make good their retreat. Had Howe followed up his success briskly and resolutely, the struggle might well have ended within the year in an outright victory for British arms, followed by a peace treaty magnanimous enough to reconcile all differences. But "Good-natured Billy" Howe, although an excellent soldier of his day, was cursed with a fundamental indolence, and openly confessed that he "hated business"—the unremitting attention to the administrative details of command that make even heavier demands on a general's energy than the actual leadership of the troops in battle.

In the outcome, desultory operations ultimately led to the capture of New York and the leisurely retirement of the Americans across the Delaware. With this much accomplished, "Good-natured Billy" thankfully retired into winter quarters where a good cellar of wine, a hand of cards, and the theatrical entertainments organized by versatile Major André served to banish all thought of tedious "business" from the commanding general's mind.

Then, on Christmas Day and in the teeth of a howling blizzard, Washington forced his way through the bobbing ice floes of the Delaware to surprise the Hessian-manned British outposts at Trenton and Bordentown, capturing 1,000 prisoners, including an indifferent brass band and a useful stock of military supplies.

Once again the score was even, and the future promised little more than a condition of exhausting and profitless stalemate. The Americans, despite the covert help given them by the French, lacked the men and matériel to stage an all-out offensive that would drive the redcoats into the sea. Yet inadequately supplied and sketchily organized as they might be, they were too skilled in the art of "bushwhacking" to be pinned down and decisively defeated with the limited number of British troops available. Traipsing hither and

thither across the entire length and breadth of the 13 States in the fond hope of bringing an elusive foe to grips, obviously was destined to yield no military dividend. What was wanted was some bold new strategic plan that would reduce an obstinate resistance to virtual impotence —and to do so before the volume of alien support for the cause of American independence had reached such a scale as seriously to threaten British victory in the field.

Such a plan was forthcoming when General John Burgoyne was ordered to hand over his command in Canada and return to England "for consultation."

Burgoyne's Plan

"Gentleman Johnny" Burgoyne had first made his name as a dashing and resourceful leader of troops in the Anglo-Portuguese campaign against the French in 1762. More recently he had been instrumental—in collaboration with the governor, General Carleton—in repelling an American attack on Canada, led by the brilliant but erratic Benedict Arnold. A man of good family, a member of Parliament, and connected by marriage with the powerful Stanley family, Burgoyne's was a voice which could command attention even in the inner circle of the government. So it was not long before his written appreciation of the current military situation in the 13 States, under the title of *Reflections Upon the War in America*, was in the hands of the King. And George III, despite his many faults, was blessed with a far keener military sense than many of his professional advisors.

Burgoyne's plan, reduced to its essentials, was for the simultaneous advance of two armies, one from Canada, by way of Lake Champlain, Fort Edward, and Saratoga, and the other from New York, by way of the Hudson. The point of junction was to be the township of Albany, over 150 miles upstream. The object of the enterprise was to cut off the New England States—the heart of the rebellion—from their sister states of the South. Split in twain and deprived of mutual support, it was firmly believed that the rebellious colonies would welcome a settlement in which a generous victor, without relinquishing over-all authority, recognized the justice of the colonists' earlier claims to a measure of local autonomy, in addition to direct representation in the Home Parliament.

Not only was the design politically farsighted—since obviously it would lead by way of a period of dominion status to ultimate independence—but despite certain technical difficulties in the way of maintaining communication between the two columns, it was militarily feasible. Everything depended, of course, on the exactness with which the movements of the contingent ascending the Hudson were synchronized with those of the force that set out from Canada. That was a piece of planning the responsibility for which rested with the Secretary of State for Colonies and War—my lord Germain.

Sackville

With the name and title of Lord George Sackville, the Secretary of State had started his career as a soldier, despite the counsel his early tutor had given the stately Duke of Dorset, "never to put his son in the army." Having regard for the fact that Sackville's elder brother when ordered to proceed on active service had refused to embark, there was more than a little reason for the cautionary advice. But it had been disregarded, and Sackville's bearing at the Battle of Fontenoy in 1745—where he had been slightly wounded—although undistinguished, had given no grounds for disparaging comment.

Thereafter, the Dorset wealth and influence having been brought to bear, promotion came rapidly; and by 1758 Sackville, with the rank of lieutenant general, was appointed second in command of an

expedition sent to raid French installations in Cancale Bay, about eight miles from St. Malo. The venture achieved no more than moderate success; Sackville's unheroic part in it was tersely summed up in the contemporary rhyme:

All pale and trembling on the Gallic shore,
His lordship gave the word—and nothing more!
'Twixt life and scandal, honor and the grave,
Quickly deciding which was best to save,
Back to his ship he ploughed the swelling wave.

Despite his extreme circumspection at St. Malo, however, the year following found Sackville in command of the cavalry in Prince Ferdinand of Brunswick's Anglo-Hanoverian force, operating near the little north German village of Minden.

Minden

With the French Generals Contades and Broglie gravely threatening the Hanoverian capital, Ferdinand launched one of the most spectacular battles in history. With unblenching courage six undermanned battalions of British Foot, supported by three Hanoverian regiments, advanced across Minden heath in the face of a murderous crossfire from 82 well-served artillery pieces. Charged three times by 36 squadrons of Gallic Horse, they blasted them with such a terrible hail of fire that they fell back in a confusion that soon spread to the 40 enemy battalions deployed between Minden village and the impassable Bog of Bastau.

With the French ranks thrown into hopeless disorder, the moment clearly had arrived for the British horsemen to turn hard-won victory into headlong rout; and Ferdinand sent hasty instructions to the British cavalry commander to lead his eager squadrons in the decisive charge.

To this order Sackville made no response whatsoever, although the Marquis of Granby, his second in command, already had wheeled about to place himself at the head of the squadrons of the second line.

Again Ferdinand's aide-de-camp, Captain Winschingrode, came pelting up with even more peremptory orders to get the Horse quickly into action; and a white-faced Sackville was heard to mutter, *"Mais, comment, mais, comment?"*

A third aide, Captain Ligonier, arrived hard on the heels of his colleague; and red-faced Colonel Sloper of the Dragoons was heard to bellow: "For God's sake repeat your orders to *that man* in plain English, that he may not pretend not to understand them, for it is near half an hour ago that he has received his orders, and yet we are still here." He added in an ominous aside, "You see the condition he is in." And indeed his lordship seemed to be gripped in a positive paralysis of inertia.

A fourth messenger was sent to Sackville, but with no result. Ferdinand's impatience waxed hot. "When is that cavalry coming?" he kept on exclaiming. "Has no one seen that cavalry on the right wing?" But no cavalry came. "Good God, is there no means of getting that cavalry to advance." he ejaculated in exasperation; and sent a fifth messenger to bring up Lord Granby with the squadrons of Sackville's second line only. Granby was about to execute the order and had the Blues in motion when Sackville rode up and forbade him; and then, as if still in doubt as to these repeated orders, Sackville trotted up to Ferdinand and asked what they might mean. "My lord," Ferdinand answered calmly, but with such contempt as may be imagined, "the opportunity is now passed."

Ferdinand's resentment at the shameful manner in which he had been robbed of the full measure of victory was reflected in the terms of his official Minden Dispatch. While full tribute was paid to Granby, the artillery leaders, and the men

of the intrepid British infantry, all mention of Sackville was studiously avoided. Unofficial comment on his poltroonery, however, soon was going the rounds in the form of a bitter little rhyme which ran:

At Minden, at Minden,
Lord Sackville sat his steed:
There galloped up an A.D.C.,
'Now take your horsemen in,'
says he,
'Montez, milor, et courez-y!'
Lord Sackville turned as pale as
death,
And strove to speak, but caught
his breath;
At Minden, at Minden.

At Minden, at Minden,
His courage him forsook;
'Make haste, sir,' cries the A.D.C.,
Lord Sackville paled and shook.
'Charge! Charge! sir,' begs the
A.D.C.,
'Mais comment donc! Comprenny
pas!'
Says Sackville, 'Moi ne allez là.'
At Minden, at Minden.

With this unflattering ditty ringing in his ears, Sackville was recalled to England and deprived of his command by a letter from headquarters at the Horse Guards which informed him that, "His Majesty has no further need of your services as a Lieutenant General and Colonel of Dragoon Guards."

The Court-Martial

With some hardihood, Sackville responded by applying for a court-martial. He was informed, with stinging irony, that this was impossible since the material witnesses were away on active service. Horace Walpole scribbled to a friend:

This letter was in the writing of Lord Holdernesse, but my lord Ligonier in words was more squab. 'If he wanted a court-martial,' he said, 'he must go seek it in Germany.' All that could be taken from him in his regiment (worth) about 2,000 pounds; his command in Germany, 10 pounds a day, 3,000 pounds to 4,000 pounds; Lieutenant General of the Ordnance, 1,500 pounds and the Governorship of a fort, 300 pounds.

Sackville, however, persisted in his demand, and a court-martial duly assembled at the Horse Guards on 10 March 1760. After a hearing of several days a verdict was returned which ended with the words: "It is the opinion of this Court, that the said Lord George Sackville is, and is hereby adjudged, unfit to serve His Majesty in any military capacity whatsoever."

The King—who never forgot that at the Battle of Dettingen his charger had bolted *toward* the enemy—endorsed the court's findings with almost savage satisfaction, peremptorily ordering that Sackville's name should be struck off the list of the army and of the Privy Council. Furthermore, to the verdict of the court-martial the angry sovereign appended his own uncompromising minute:

It is His Majesty's pleasure that the above sentence be given out in public orders, that Officers, being convinced that neither high birth nor great employment can shelter offense of such a nature, and seeing that they are subject to censure much worse than death to a man who has a sense of honor, *they may avoid the fatal consequences arising from disobedience of orders.*

The final comment came from Sackville's invertebrate elder brother who complacently remarked: "There! I always told you that George was no better than myself!"

Politics

The court-martial which adjudicated on Sackville's conduct did its duty fearlessly and without favor. It made only one mistake—in not leaving out the word "military" from its sentence of dismissal. Had

the verdict run, ". . . unfit to serve His Majesty in any capacity whatever," it would have been impossible for a man who had legitimately been hounded out of the army to creep back to ministerial office by way of the grubby backstairs of politics.

As it was, the Dorset influence set quietly but steadily to work to rehabilitate by far the least worthy of a by no means illustrious line. A judicious change of name, engineered on succeeding to a substantial fortune, enabled "the Great Incompetent" of Minden to submerge himself in the rising politician, Lord George Germain.

It followed that by the time of Britain's quarrel with the American colonists, the defendant in the already shadowy court-martial of March 1760 had attained to a position of such political influence that his succession to the Earl of Dartmouth as Secretary of State for Colonies and War was a foregone conclusion. Thus it came about that the implementation of Burgoyne's far-reaching scheme for the subjugation of the rebellious colonies was entrusted to a man who combined a consequential arrogance, as head of department, with an ineptitude and inertia that only too faithfully reflected the fatal want of energy he had exhibited in the field.

This, then, was the man to whom had been confided the delicate task of coordinating the movements of two armies, separated by something like 250 miles of extremely difficult country, and lacking all modern means of maintaining intercommunication.

Coordination

As a preliminary, of course, it was necessary to inform General Carleton, in Canada, and "Good-natured Billy" Howe, in New York, of the design that had been worked out and agreed upon in London. A letter in which the plan was outlined in general terms was, therefore, drawn up for the information and guidance of Canada's Governor General. At the same time, a copy of the document was put in hand for dispatch to General Howe in New York. The intention was to accompany the latter with detailed directions for the movement of Howe's troops up the Hudson, to ensure his punctual junction with Burgoyne at Albany.

As it transpired, no such instructions ever left Whitehall!

As Lord Shelburne subsequently recorded:

Lord George, having among other peculiarities a particular aversion to be put out of his way on any occasion, had arranged to call at his office on his way to the country in order to sign the despatches; but as those addressed to Howe had not been 'fair copied' and he was not disposed to be baulked of his projected visit into Kent, they were not signed then and were forgotten on his return to town.

What actually had happened subsequently was revealed by William Knox, the Under Secretary for the Colonial Department. He informed a committee convened to investigate the matter:

There certainly was a weak place in Lord Sackville's [Germain's] defense which was the want of an official communication to Howe of the plan, and Burgoyne's instructions, with orders for his cooperation. After Burgoyne had been appointed and the necessary documents drawn up, when all was prepared and I had them to compare and make up, Lord Sackville [Germain] came down to the office on his way to Stoneland, when I observed to him that there was no letter to Howe to acquaint him with the plan or what was expected of him in consequence of it. His Lordship stared and D'Oyly [the Deputy Secretary] started but said he would in a moment write a few lines. 'So,' says his Lordship, 'my poor horses must stand in the street all the time, and I shan't be to my time anywhere.' D'Oyly then said he had better go, and he would

write from himself to Howe and inclose copies of Burgoyne's Instructions *which would tell him all he would want to know, and with this his Lordship was satisfied as it enabled him to keep his time, for he could never bear delay or disappointment.*

In the outcome neither Germain nor D'Oyly gave the matter a second thought. Howe received no copy of Burgoyne's *Instructions*, nor any order to coordinate his movements to conform with them. Instead, he sauntered off to fight the Battles of Brandywine and Germantown, and to capture—and be captured by—the strategically unimportant city of Philadelphia. "Gentleman Johnny," baulked and predoomed to failure by the minister's stream of contradictory instructions, with his supplies exhausted and his famished troops "right out on a limb," had no option but to surrender to the superior forces commanded by Horatio Gates.

In effect my lord Germain, who ruined the chances of an overwhelming victory at Minden by *not* being in a hurry to advance against the enemy, threw away a continent by *being* in a hurry to spend a weekend down in Sussex.

The Effect

Moreover, he gravely imperiled England's own safety, for the British defeat at Saratoga brought France openly in the field against her age-old enemy. Spain was not long in taking example from her Gallic neighbor, and Holland speedily followed suit; while Russia and the Scandinavian countries declared an "armed neutrality" that undoubtedly operated to England's grievous disadvantage. With a Franco-Spanish fleet lording it in the English Channel, Gibraltar under close-pressed siege, and Gallic forces operating in North American waters and in cooperation with the Continental armies, the far-ranging consequences of Germain's criminal negligence were within an ace of bringing England to her knees.

In a global struggle that fully qualifies for the title of World War I, America gained her independence from England not as the outcome of an honest compromise with a foeman worthy of her steel, but at the cost of a Gallic support as irksome and exacting as the colonial status she had earlier repudiated. And two world conflicts were required to exorcise the bitterness, on both sides of the Atlantic, the unnecessarily protracted years of struggle inevitably had bred.

As for the egregious Germain—well, it is far easier to disgrace a soldier like Burgoyne (or shoot an admiral like Byng) than to visit retribution on a politician who has failed his trust. Threats of impeachment thundered out by the opposition naturally came to nothing, for in the murky game of politics dog does not eat dog. In effect, the political ineptitude of Minden's "Great Incompetent" had been on such a stupendous scale that no one could afford to admit it.

With the fall of Lord North's administration in 1782, Germain disappeared permanently from a political scene which, but for the hasty wording of a court-martial sentence, might well have been spared his disastrous presence.

Germain was doubly guilty—of the sins of omission *and* commission. For the most part, however, the politician's abiding fault is not so much negligence as gross and entirely unwarrantable interference in military matters entirely outside his competence. Entrusted with ministerial responsibility for a service department, he immediately conceives himself as endowed with the military insight of an Alcibiades. Strategy and the science of logistics by which it is supported—to the study of which his service subordinates have devoted a lifetime—are matters on which he at once proceeds to lay down the law. The outcome of his dangerous aberration is that the chiefs of staff find themselves with two wars on their hands—one with

the known enemy, and another and scarcely less bitter conflict with the amateur strategists holding ministerial office.

The Spanish Armada

There is nothing new about this phenomenon, for a particularly pernicious example of *Kabinetskrieg* on the part of an administration lacking in all the qualifications to justify intervention occurred as long ago as 1588. With Philip of Spain's mighty armada concentrated in Lisbon, Vigo, and La Coruña, only awaiting a favorable wind, Drake and Lord Howard of Effingham had mustered a strong fleet at Plymouth, alert and ready to nip any attempt at invasion in the bud. It was on 30 May that the Grand Armada set sail; but it was not until 5 July that Gilbert Lee, master of the *Rat of Wight*, brought the news that a violent storm, plus a shortage of provisions, temporarily had driven the Spanish vessels back to the shelter of La Coruña.

It was obvious that the respite was no more than temporary, and fine weather supervening, the English fleet set out on a reconnaissance in strength in the channel's western approaches. On returning to Plymouth, Howard was met by a peremptory order from the administration to disband half his fleet. At the same time, Drake received a sharp reprimand for having "wasted" powder and shot in exercising his gun crews in target practice. It was a command which only too faithfully reflected not only the Queen's congenital parsimony but the cretinous pusillanimity of her councilors, only too eager to read in the armada's fortuitous nonappearance a desire on the part of Spain to negotiate peace.

In Plymouth, fortunately, a greater sense of reality persuaded Howard of Effingham to keep every available ship ready for the fray. This entailed very considerable sacrifice and discomfort, for rations had to be cut to half measure, and even then required to be supplemented by provisions the Lord High Admiral paid for out of his own pocket. To keep the fleet in being was, of course, an act of flagrant disobedience. But had Howard yielded to the administration's misguided intervention, there would have been little with which to confront the armada when it duly made its appearance off the Lizard on the fateful morning of 30 July.

Although the instance cited here occurred in the reign of a monarch as notable for her sense of absolutism as for her faculty for procrastination, intermeddling by the administration in matters outside its province is far more characteristic of parliamentary governments—and of an ultrademocratic executive above all.

Another Example

In 1702, when the Duke of Marlborough took up command in the Netherlands, the British forces were joined by a considerable body of Dutch troops, more than a little demoralized by the rough handling they had experienced recently at the hands of the French Marshal Boufflers. They were accompanied by two deputies of the demagogic States General; and two more obstructive representatives of an administration it would be difficult to imagine.

Rapidly concentrating some 60,000 troops, Marlborough marched to within two leagues of Boufflers, and having caught the Frenchman at a disadvantage was eager to give battle. This was a course the deputies absolutely refused to countenance, insisting that Marlborough should remain on the defensive.

With unwearying patience the Duke bore with the restraints imposed upon him, and within a few weeks, by a series of rapid marches, he again had the French at his mercy, entangled in difficult country and in great confusion. This time the deputies categorically refused permission for the Dutch contingent to move, and a second great chance was denied a commander quite capable of turning it to superlative advantage. There still was a

good prospect of success, however, if attack were pressed home on the following day. But once more the purblind, pig-headed deputies intervened, and a third great opportunity was sacrificed to the timidity born of ignorance. Yet a fourth chance was thrown away, and for a similar reason. It was not, indeed, until Marlborough had built up his own strength sufficiently to operate, if need were, without Dutch assistance that he was free to give his enemies a taste of his quality which faithfully foreshadowed the resounding victories that lay in store.

Revolutionary Times

Few men can have suffered more from high-handed but peculiarly inept interference on the part of the administration than George Washington. Narrow, ignorant, with few of it members boasting political experience on any larger scale than that of the town meeting, Congress meddled with the conduct of the armies in the field at every level. John Adams proposed appointing a new set of generals every six months; while Benjamin Franklin advocated arming the Continental troops with bows and arrows "to save money on muskets and powder." Without capacity for forming intelligent judgments itself, this peculiar body exhibited a consistently perverse capacity for overriding the judgments of its ablest soldiers at the whim of its most incapable members.

As Bossuet once pointed out, "There is nothing so dangerous as active ignorance"; and the American colonists won their independence in spite of Congress, not because of it.

There can be few more striking examples of the pernicious effect of administrative interference with military activities than those furnished by the French National Convention in the early days of the struggle against the combined forces of Britain, Austria, and Prussia. Mistrusting their commanders in the field as profoundly as they suspected each other, men such as the vindictive Jacobins, Bouchotte, and Vincent, created their own local reigns of terror in the zones of the armies. This they achieved by means of representatives who, acting on confused and contradictory orders from Paris, intervened in the conduct of military operations with an ineptitude that positively invited catastrophe. Since they were armed with arbitrary powers and accompanied, in at least one instance, by a traveling guillotine, their hold over the unfortunate field commanders was absolute.

Custine, Biron, and several other general officers suffered decapitation for reverses in the field which had been occasioned largely by the ignorant meddling of a handful of swaggering oafs entirely unschooled in the conduct of war; while Berthier—subsequently Napoleon's brilliant chief of staff—nearly experienced a similar fate.

At this period, however, the British Cabinet was encumbered by the inclusion of a certain Henry Dundas, a pettifogging Scottish lawyer, who had contrived to beguile the Prime Minister into entrusting him with the post of Secretary of State for War. Over and over again he interfered, for no perceptible reason, to remove or transfer troops at a highly critical juncture, or in the heat of battle fighting, without bothering to notify the field commanders beforehand. In the *History of the British Army*, the late Sir John Fortescue has recorded:

> *The incoherence and folly of his orders may best be judged from a summary of the reply which Murray, the British Chief of Staff, at length found time to write on 20 October (1793). 'Let me point out to you,' he wrote, in effect, 'that the same messenger brought to me from you, first, advice to besiege St. Quentin; secondly, orders to keep a body of troops at Ostend; and, thirdly, strong exhortations against* division or detachment of our force.'

A few years later another British com-

mander, General Sir Charles Stuart, was constrained to acknowledge a mass of coagulant and contradictory *directives* from the same source with the shattering retort, "I am determined to be guided by your instructions so long as they are within reach of my comprehension."

"An army in the field," said Cicero, "is of dubious value unless there be wise councils at home." Yet that most temperate of historians Sir John Fortescue once pertinently commented: "It is a weakness of politicians, who rarely understand their own business, always to aspire to set right the business of other people." Indeed, the passion for interference characterizing the members of the average civil administration appears to be ineradicable. Time cannot wither nor custom stale their infinite contrariety which persists despite the fact that their own intermeddling may well jeopardize the issue for which *they* bear ultimate responsibility.

Restraint

The invention of the electric telegraph furnished departmental Hectors with an even speedier means of inflicting their views and suggestions on the soldier conducting operations in the field. In the Crimea, for example, both Raglan and Pelissier were the victims of constant nagging, over the wires, from their respective governments, until the unfortunate Frenchman was impelled to protest that, "You cannot run a war from the Tuileries."

It was Queen Victoria who perceived the dangers latent in faster means of communication. At the time of the operations in Egypt in 1882, she wrote to her Prime Minister:

The Queen would draw Mr. Gladstone's attention to the great and indeed vital importance of not interfering *with or* directing *Sir Garnet Wolseley's movements, but leaving a great deal to his judgment and discretion. It is well-known what harm was done in bygone times by the Aulic Council interfering and hampering the actions of Generals in a campaign; and now with the telegraph always at hand, interference from home, and especially by civilians, might be—to say the very least —very injurious. The Queen must strongly and earnestly protest against this.*

Whatever the effect of this wise injunction on Mr. Gladstone, it is certain that some of his successors in office have thrown off all vestige of restraint. Mr. Lloyd George's mischievous interference in strategic matters, his feverish search for some type of cheap military success to serve as a political window dressing, and his deliberate withholding of the men needed to meet Ludendorff's offensive of March 1918, are all matters of record. Nor do the revelations of the Allanbrooke "Diaries" encourage the belief that men in high places are prepared to learn from the follies of their predecessors.

"In time of war," wrote Fortescue, "governments always claim, in the name of patriotism, that the nakedness of their incapacity shall not be uncovered." That is comprehensible enough, since little good ever derived from crying stinking fish.

What Is Needed

What *is* wanted, however, is a definite pattern of responsibility by which wartime governments would abide. Responsibility for policy must, under a democratic constitution, rest with the civil administration. That is unquestioned. But once a certain line of military policy has been decided upon—and the means provided to implement it—its untrammeled execution should be left to the soldiers, sailors, and airmen who are best qualified by training and experience to carry it out. When something goes wrong with the plumbing, you do not call in the baker, but send for the trained expert who best knows how to put things right. And metaphorically speaking, what is warfare but a breakdown in international plumbing?

Armed Force in Support of Government Policy--1970

Digested by the MILITARY REVIEW from a copyrighted article by Major Guy Armstrong in "The Journal of the Royal Artillery" (Great Britain) October 1957.

THREE times in history the pattern of war has been changed fundamentally by the discovery of a new and powerful form of energy. The first occasion was when gunpowder provided a highly efficient and novel means for slaughtering the enemy. In the second case, the invention of the internal combustion engine made possible the development of aircraft, tanks, and motor transport, providing increased mobility and security rather than greater lethality of armaments. As a result, the 20th century already has seen swift and startling changes in the shape of the armed forces.

Now, following the dropping of the first atom bomb in 1945, we stand poised for another great stride in the art of war. It must be remembered, however, that although we know how to release nuclear energy, we are only just beginning to learn how to harness it, and it will be some years yet before its impact on the armed forces can be assessed fully. In considering the effect of this new source of energy, there is a danger that we may attempt to apply it in the context of current political and military conditions, rather than in the light of those which will apply when it has been developed to its fullest effect.

The Struggle

The basic role of the armed forces is to maintain such a condition of national security that the policy of the government may be put into effect. We should, therefore, consider the world setting which is likely to exist when nuclear energy will have taken its conventional place in the services. At present, British foreign policy is governed mainly by the clash between the Western Powers and communism, in the form of overt and covert political action (cold war), of military conflict with confined geographical areas such as Korea (limited war), and of the threat of global war with thermonuclear weapons. At the same time, we have to deal with a rising tide of nationalism in our dependent territories, often stimulated by Communist intervention.

It is impossible to say how this struggle with communism will develop in the future, but it would be folly to plan on any situation which is very much different from that now in force. Even if the tension between ourselves and the Communists should dissolve, there looms on the horizon the possibility of worldwide racial conflict in which Britain might become involved indirectly. On the other hand, the march of colonial territories to independence soon will reach a stage when there will be few places left in which armed force might be required to support British civil power.

It is known that it takes up to 10 years between the concept of a new major equipment and its arrival in quantity in the service. It is public knowledge that nuclear and thermonuclear weapons are being developed for our armed forces, and that guided weapons and ballistic missiles also are being developed, both as offensive and defensive weapons. While it is very difficult to assess any particular date by which nuclear energy will have achieved full effect in our forces, it seems reasonable to assume that this can hardly be much before 1965-70.

Future Tasks

Let us now consider what tasks might be given to our forces in 1970. Limited or global war seem to be the main tasks,

with the emphasis on the former. This is because the increasing potentialities of thermonuclear weapons suggest that neither side would take the initiative in using them except in desperation. There is likely to be a much reduced need for internal security assistance to civil authorities. The main roles of the armed forces, therefore, will be to provide a deterrent against global war, and to be prepared to take part in limited war in the defense of our vital interests in the Middle East or Far East.

In global war the armed forces must be prepared to operate not only the guided missiles which will carry the thermonuclear weapon, but also our defenses against enemy guided missiles, submarines, and aircraft. By 1970 it seems probable that aircraft as offensive or defensive vehicles will be obsolete, and that they will perform a purely transport and reconnaissance role.

Once thermonuclear weapons have been used, the armed forces will have another immense task to maintain law and order in our own territories, and to assist in restoring essential supplies and services. In due course, they also will have to perform this latter task in enemy territory, after we have occupied it.

It is thus clear that we shall need a high degree of strategic and tactical mobility for our forces, whose weapons will comprise thermonuclear and nuclear warheads of varying sizes (delivered by ballistic missiles, guided weapons, and guns), antisubmarine weapons, antiaircraft/missile guided weapons and guns, medium and close support artillery (some of which may be tankborne), antitank guided weapons, and infantry mortars and small arms.

Thus armed, the tasks allotted to our forces are likely to be the maintenance of vital sea and air communications, the restoration of law and order in such dependent territories as still remain under our control, limited operations (excluding thermonuclear weapons) in defense of vital economic interests in the Middle East (oil) and the Far East (tin and rubber), and, in the last resort, full global war against the Soviet bloc. The last task will include the air defense of the United Kingdom, and assistance to the civil power in restoring the means of life after thermonuclear attack on Britain.

Organization

What broad organization of our armed forces should we develop in order to carry out these tasks? The battle for our air and sea communications will require a complex submarine, surface, and air weapons system closely integrated and centrally controlled. Apart from the United Kingdom, overseas ports and airbases also will need to be defended, and it would seem that a single organization should be responsible for all these activities. This should be built around our present navy, with that part of the air force which is concerned with antisubmarine operations and the operation of surface-to-air guided weapons.

Strategic ballistic missiles probably will be capable of being launched from land or ships. There would seem to be every advantage in incorporating this function with those of the combined navy/air force, and intertheater transport aircraft also should form part of this force.

So far as the land battle is concerned, the present shape of the army is unlikely to alter very much (although it probably will be smaller than at present), and it should be responsible for manning the mobile surface-to-air and surface-to-surface guided weapons which it needs for its own operations. Aircraft employed within the theater of operations for the maintenance and transport of the army, air observation post, and tactical reconnaissance aircraft also should be part of the army.

Two Services

The conclusion thus appears that in 1970 our armed forces should consist of

two services, based on the present navy and army, the residual functions of the air force being divided between them. The security of our strategic air and sea communications, and the operation of strategic ballistic missiles, would be the responsibility of the navy, while the army would be responsible for all land and air operations within theaters. This reorganization should be timed to take place gradually, as the arrival in service of ballistic missiles and guided weapons renders fighter and bomber aircraft obsolete. It should be complete by 1970.

The disappearance of the Royal Air Force as a separate entity clearly must be extremely painful for all its members, and for the country as a whole. The decision must, nevertheless, be made if the armed forces are to be effective in maintaining the physical security of the nation in an age when their armaments are demanding an increasing and appallingly large proportion of the country's economic resources. In the last resort, sentiment must yield to realism, and we will not deserve to keep our place in history if we shirk unpleasant decisions.

Nelson's Nuclear Navy

Digested by the MILITARY REVIEW from a copyrighted article by Dudley Pope in "The Navy" (Great Britain) December 1957.

Let us imagine Lord Nelson is the First Sea Lord today; the man Lord Mountbatten said we would be happy to feel, had he been alive, 'would have been in the forefront of those who want us to play our full part in the revolutionary period in naval warfare which lies ahead of us.'

NELSON is considering the fleet we should be planning to have in 19 years' time. He has just left the Prime Minister after a considerable disagreement over present and future defense needs, and in his office at the Admiralty he is striding up and down, his one sound eye gleaming, the empty sleeve pinned across his breast, and he is dictating to a secretary:

My dear Prime Minister:

Yesterday it was my melancholy duty, in company with the First Lord, to inform you that because of the vacillating and unrealistic defense policy at present pursued by Her Majesty's Government, and because of the Admiralty Board's dissatisfaction over certain aspects of the present Minister of Defense's policy, it should put its views on record. In addition, the board wishes me to emphasize that in their opinion a Minister of Defense should define the over-all defense plans, leaving the individual service ministries, with their expert knowledge, to handle their own affairs. This is not the case at present, and it is feared that the Ministry of Defense soon will develop into a feudal court.

In accordance with your requests, I am placing the views of the board in writing and at the same time outlining the navy for which, in my opinion, the government must strive now in order to have it in being at the latest by 1976.

We must work on the following assumptions:

1. The threat from Russia continues far into the foreseeable future.

2. Some type of military alliance, preferably more realistic and effective than at present, continues among the Western Nations.

3. No effective defense against inter-

continental ballistic missiles (ICBM's) is likely to be found in the period under review.

4. Following from this, Britain is incapable of being defended from attacks by ICBM's.

5. An East-West war is likely to break out under only two circumstances —as the result of a diplomatic miscalculation by one side or the other in connection with localized circumstances such as Korea or Suez; or by a deliberate and calculated sudden attack by Russia on "Pearl Harbor" lines, designed to eliminate the West as a military force.

In either case I think the West would be attacked on a vast scale with no warning from diplomatic or intelligence sources. If the attack followed a "Suez," the West might have mobilized a small proportion of its depleted reserve forces. This leads me to my main criticism of present and future defense planning: *it does not work on the vitally important basic assumption that in a future war the West can fight only with those forces which are operational at the time of an attack by Russia.*

Irrespective of the views of the government or of political expediency, I consider this the only basis for planning the navy—or indeed our entire defense—for 1976.

The utter rubbish talked in certain official circles about the type of war likely to be waged at that time forces me to restate my own views in order to describe the ships and weapons we shall need. The attack will be sudden and, if premeditated (that is, not the result of a diplomatic mistake), it will be devastating. The Russian objectives would be threefold:

First, heavy nuclear attacks by ICBM's, IRBM's (intermediate range ballistic missiles), and manned bombers on perhaps 1,000 to 2,000 strategic targets in the West. These targets would be chosen carefully and aimed primarily at destroying the network of bases, and their communications, from which missile and bomber counterattacks could be launched.

Second, the entire destruction of such political, communication, and defense "nerve-centers" as London, Washington, Paris, Oslo, and Malta, with the aim of creating final and complete confusion among NATO powers so that no political or defense decisions could be taken or, if taken, passed on.

Third, the devastation of all major naval and commercial ports in Europe which would be of use to the West in maintaining or regaining a foothold on the Continent. This would be done by direct nuclear attacks, probably with the additional use of "Trojan horse" merchant ships carrying nuclear devices in their holds.

This nuclear attack would, if complete surprise—and thus success—had been achieved, be followed by the physical invasion of Europe, the Middle East, and, through and with the help of China, the Far East. The Russians would aim at securing certain bases from which to make further physical invasions.

One or more major ports in Europe, perhaps Cherbourg and Le Havre, might be reserved for the physical invasion of the United Kingdom, to be destroyed later should Soviet troops be so delayed in their invasion that Britain and the United States were able to make use of them.

Since Russia would be the aggressor, the West must always regard itself as delayed in its response to an attack. It is no good placing any reliance on intelligence sources or on radar, infrared, and other forms of warning and detection. The bombs might be delivered by Soviet civil aircraft, apparently, until the time of the attack, engaged peacefully in carrying passengers, apart from the use of "Trojan horse" merchant ships and indeed "Trojan houses" in which Soviet agents and sympathizers have constructed nuclear devices.

Having visualized the type of attack, we must consider first, the method of counterattacking in general, and second, the navy's role in particular. As planned at the moment, the West's counterattack would be delivered initially by Strategic Air Command; but in 1976 the Ministry of Defense, with other countries, places its entire faith in ICBM's—launched presumably from those sites not smashed or isolated by the initial Soviet attack.

The way the war continues after the first nuclear exchange is far from clear in the minds of the government and the Ministry of Defense, and there are many misconceptions. One thing is certain, by 1976 nuclear missiles will be available in large numbers and nuclear warfare is unlikely to stop simply because one side or another runs out of supplies. It is more probable that both sides eventually will stop either because one has been so devastated that it cannot launch more, or both realize that radiation has reached a dangerous level.

In my view it is extremely unlikely that in 20 years' time an initially nuclear war would convert itself into a war of conventional weapons.

This brings me to my second point, the navy's role. As weapons have changed, so must our strategy. The time has come to consider whether the navy's traditional role takes on, for the period under review, an additional aspect. As well as being charged with keeping our sealanes open, I consider the Western navies, properly planned and developed, the only arms which can be relied on to be in a position to retaliate immediately after a surprise nuclear attack.

My reasons for thinking this are quite simple. Nuclear weapons at last provide a country with the ability to *destroy* ports, instead of only damaging them by conventional bombing or temporarily closing them by mining. Russia admittedly is developing a large submarine fleet—against which we must plan and build in the present transitional period—but much of this will be rendered obsolete by 1976.

Rather than make her decisive challenge to our seapower *at sea*, although she could do this quite effectively if she continues her present technological trends, she can just as easily and far more effectively cut our sealanes by smashing our ports. By smashing I mean completely razing, a devastation that few people can visualize.

It follows from this that governments and admiralties of the West should stop trying to divide future wars into administratively neat compartments. Neutralizing ports is as much an attack on seapower (as well as being far swifter and more effective) as an attack on ships at sea. A bee cannot make honey without a hive; those survivors in Britain would starve even if fully laden merchant ships waited offshore, unable to unload the minimum of a million tons of supplies needed each week. Little trust can be put in artificial ports like the *Mulberry* of the last war, when troops took supplies with them in their own transports. Destruction of ports presupposes complete destruction of railway and road centers.

The navy—by this I mean the warships of the West—will have to retain effective control of the sea in the traditional way but with far from traditional weapons. Granted that the Continent and possibly Britain are overwhelmed by the initial nuclear attack, then the counterattack will have to come from America, from the Commonwealth, and those parts of the world still free.

However powerful nuclear weapons become, physical occupation of invaded territory will be necessary. Despite the extravagant claims of the airmen, the navy will be the only means of preventing the enemy debouching in sufficient numbers from any European or Asian sally port into the new world and the antipodes. Similarly, the navy later would attempt to safeguard

the forces of liberation bound from those areas.

No doubt I shall be accused of defeatism for my gloomy view of the effectiveness of our defenses *as planned at present* in the event of a sudden attack by Russia. There is a brighter side, however, providing we are given the navy I consider necessary, and that NATO navies develop in a parallel fashion.

To recapitulate: the disadvantages facing the West—given that it carries on as it is now—are the certainty that valuable time will be lost because Russia will attack first and the West's resultant counterattack will be weakened by the violence and scale of the assault; the possibility of the loss of the war at sea because of the destruction of ports and the merchant and warships in them; and the possible neutralization of the bases of retaliatory weapons.

The major problem the West faces then is how to ensure it can counterattack within a matter of seconds, however badly it is "Pearl Harbored."

It is useless to rely on fixed ICBM's, IRBM's, and airbases. One of the disadvantages of the democratic way of life is that the enemy or his sympathizers are free to find out such information as the whereabouts of such bases, either from the press or from a systematic search under the guise of tourism. His missiles thus can be aimed ready for the moment of attack without the West knowing that his preattack reconnaissance already has been made.

An immediate and effective ICBM and IRBM counterattack which can be relied on will be possible only from highly mobile launchers which can change their position frequently and secretly, ever on the alert to launch their missiles at preselected targets at a few moments' notice.

Submarines

Nuclear-powered and submersible cruisers—I shall refer to them as missile submarines, since they are the logical successor to the submarines we know today —are the only launchers possible.

We must, therefore, ensure that, by the period under discussion, we have such nuclear-powered missile submarines in service, capable of high speed and able to stay at sea for a year at a time without relief. As soon as they are completed, these vessels should be sent off to their patrol areas so that every hour of the day, year in and year out, they are watching, waiting, *and ready.*

It will be *position* that matters, not speed; immediate readiness, not potentiality. That surely is the main lesson history has taught the United Kingdom. The country's potentiality in a future war will be that of the men and weapons operational at the time of attack; there will be no time to build shadow factories and prefabricated ships, no time to change our defense plans or tempo.

There are many problems arising from the designing and building of such missile submarines and the board is anxious that I do not underestimate them in this memorandum. In order that they should launch their missiles accurately, for instance, their navigational equipment must be capable of fixing their position at sea within a matter of yards. This equipment alone will cost between eight and 10 million dollars for each submarine.

These missile submarines will, in my opinion, form the West's striking force, replacing the navy's present woefully inadequate carrier task groups. Thus irrespective of the scale and suddenness of an enemy attack we can fight back.

We must, however, be in a position to reammunition these missile submarines and other warships even if our bases are "Pearl Harbored." The only way we can do this is by having mobile bases, in effect depot ships. These must be placed strategically throughout the oceans of the world, always ready to assist not only those mis-

sile submarines already in position but others which might be switched to more remote areas.

These mobile bases also would form a mobile headquarters so that the fight can, should the occasion arise, be continued from isolated areas independent and irrespective of the positions the West holds or has lost on land.

These base ships must be submersible. I visualize nuclear-powered vessels of perhaps 10,000 to 12,000 tons, capable of carrying considerable quantities of missiles, food, spare parts, and other supplies, as well as crews.

Defending these ships from either air, surface, or underwater attack would be submarine escort ships armed with surface-to-air and surface-to-surface as well as underwater guided missiles; they would have the latest air, surface, and underwater detecting devices and would be capable of high speeds.

The bases would, in fact, be submersible fleet trains defended by their own submersible task forces. At least one ship in each convoy would be a headquarters ship equipped with the requisite communications gear and planning staff.

The task of designing these submersibles is not as great as would at first appear. The propelling machinery, for instance, perhaps would be less than half the size of conventional machinery, which might mean a considerable amount of extra cargo, crew, or weapons space without an increase in hull size.

Aircraft still will be necessary for routine antisubmarine patrols and reconnaissance, and for acting as ferries in the way helicopters are used at present. They must be capable of both high and low speeds and the vessels carrying them must be submersible.

The ideal machines would be those capable of vertical takeoff, since their ability to hover would not detract from their speed, and also they would need only a very small and rudimentary flight deck. This means that the submersible carrier could be quite small in size—certainly not above 15,000 tons—and providing that it had flat landing platforms, the only extra equipment needed would be for stowing the aircraft below.

The submarine carriers could operate with their own escort force in the same way as the mobile bases and would have to have high speeds, long endurance, and be capable of all necessary repairs to both aircraft and the vessels themselves.

The mobile bases and carriers must be submersible because the success of their operations rests entirely on the secrecy of their movements. Whatever advances are made in submarine detection, the enemy aircraft or ships must be fitted with special equipment to detect the vessels underwater. In the case of surface forces, a single-engine enemy aircraft equipped with radio is enough to detect them.

These three major types of ships—the missile submarine, the submarine base ship, and the submarine carrier—thus will form the capital ships of the future navy. Specialized escort submarines capable of dealing with air, surface, and underwater attack will replace the destroyers of the present. With these ships it will be possible to counterattack and to defend. In the event of it being possible to sail merchant ships on the surface in convoy, then these ships still are capable of defending against all forms of attack—except ICBM's and IRBM's.

Further, the vertical takeoff aircraft must be capable of being adapted to hunter-killer roles, capable of searching out the submerged enemy and launching powerful guided weapons against them, must have considerable range for reconnaissance, and have considerable speed for evading or intercepting enemy aircraft.

I visualize that both sides will be reduced to using aircraft for reconnaissance during the period under consideration.

Neither side will have developed missiles capable of effective reconnaissance, nor will they be able to rely on radar or infrared. Rocket missiles capable of homing on radar transmissions will rule out the former, while one assumes the enemy, like us, will find methods of tampering with the efficiency of the latter.

With the great advances made in direction-finding and cypher-breaking, radio will have strictly limited uses, so ships may well find themselves relying on their own resources and information in the same way as sailing ships did in the days of Trafalgar.

Perhaps the greatest advantage, from an economy point of view, of the navy I have outlined is that it would be quite effective in a limited war using nonnuclear warheads. The ships are the ideal compromise for both all-out nuclear and conventional limited warfare, yet they have none of the disadvantages usually found in a compromise.

The reason for this is, of course, that they are not *designed* as a compromise: they are specifically designed to fight a nuclear war, but it is a fortunate coincidence that by changing the warheads for the various weapons they carry, they can revert to conventional roles.

The mobile bases will overcome one of the difficulties caused by the present trend of withdrawing from Commonwealth countries. Political expediency seems to require that we give up many vital naval, land, and airbases without explaining to the country involved that their freedom and defense is inextricably linked with ours.

It goes without saying that the missile, base, and carrier submarines must be built in sufficient numbers to be effective, and it will be necessary to convince the NATO powers that they must build their contribution of these ships. The effectiveness of the missile submarine, able to counterattack at once, lies in its numbers.

The board asks me to stress certain other points. It is absolutely necessary, in their view, that Her Majesty's Government convinces Parliament, the press, and the people that we will fight the next war with those men and weapons operational at the time of the attack. This will go a long way—if not all the way—toward explaining why defense costs must be even higher than at present.

Latest figures show that defense costs $1.47 a week per head of the population. The average London household spends 44 cents a week on radio, television, and musical instruments; 49 cents on sweets and chocolates; 90 cents on alcoholic drinks; $2.30 on tobacco; nine cents on ice cream; and approximately 59 cents on betting losses.

The average person would, I am sure, if the dangerous defense situation was clearly and honestly explained to him, agree that this is a high price to pay for luxury when we should be buying security.

The more powerful our Nation's total retaliatory capability, the less chance there is of atomic war. The more combat-ready our Navy's retaliatory forces, the less chance there is of atomic war. And if war should be triggered off—either atomic or nonatomic—the better the Navy, the better are our chances to win it.

Admiral Arleigh A. Burke

speed, and also they would need only a

during the period under consideration.

BOOKS OF INTEREST TO THE MILITARY READER

DRAMA ON THE RAPPAHANNOCK. The Fredericksburg Campaign. By Edward J. Stackpole. 297 Pages. The Military Service Publishing Co., Harrisburg, Pa. $4.75.

BY LT COL ROBERT J. LOW, *Arty*

When, on 25 January 1863, the President of the United States issued the order directing him to pass command of the Army of the Potomac to Hooker, Major General Ambrose E. Burnside lost the last battle of the Fredericksburg Campaign. This was the battle of accusation and recrimination begun when Burnside issued his infamous General Order Number 8 dismissing from the service all but one of the Federal troop commanders at Fredericksburg in December 1862—officers who had fought valiantly and well against odds, which, if not created certainly were compounded by the ineptness and procrastination of that same Burnside.

This book is primarily the story behind that historic order. The author begins with the events leading to Burnside's assumption of command and then covers the happenings when the Army of the Potomac and Lee's Army of Northern Virginia grappled for the road to Richmond.

The author covers only a small segment of a long war, but does it in detail and does it well. The additional emphasis afforded the personalities involved does much to add interest for the casual reader as well as the professional military student.

Although better titled, "Lincoln Sent a Boy," this volume is a fitting companion to the author's *They Met at Gettysburg.*

THE ROCKET PIONEERS. On the Road to Space. By Beryl Williams and Samuel Epstein. Introduction by Dr. Wernher von Braun. 241 Pages. Julian Messner, Inc., New York. $3.75.

BY MAJ PATRICK W. POWERS, *Arty*

The story of the pioneers in any field of endeavor always is inspiring. In this age of missiles and satellites, a brief review of the men responsible for the basic progress in rocketry today is not only timely, but also will explain some of the complexities of this vital science. The approach of the rocket pioneers to the theory and construction of rockets provides a valuable understanding of this ascending military weapon.

The second printing of this popular book emphasizes the latest satellite firings as another milestone that was charted over a quarter of a century ago. The contributions of William Congreve of England, Jules Verne of France, Dr. Goddard of the United States, Professor Oberth of Germany, American and German rocket societies, and, yes, even those of the Russian theorist Ziolkovsky are all covered in a fascinating, biographical style. The lives of these great men have left "rocket trails in the skies of time" that the military reader will enjoy viewing in this book.

EXHIBITION DRILLS. By Captain William M. Glascow, Jr., United States Army. 198 Pages. The Military Service Publishing Co., Harrisburg, Pa. $2.50.

ILL-STARRED GENERAL. Braddock of the Coldstream Guards. By Lee McCardell. 335 Pages. University of Pittsburgh Press, Pittsburgh, Pa. $6.00.

BY LT COL HAROLD E. BEATY, *CE*

On 8 July 1755 Major General Edward Braddock, an officer of the proud Coldstream Guards, marched his small army of 6,000 into a situation that ended in defeat and rout after a short engagement against a small force of French and Indians in southwestern Pennsylvania. During the fray, while personally attempting to reorganize his troops, he received a bullet wound from which he died four days later. This ended the career of a colorful personality who followed in the footsteps of his father and had spent his complete life in the British military service. On that fateful day General Braddock marched inevitably to his tragic end and in a world where success paid off in incredible wealth and prestige, and failure brought poverty and disgrace.

Historians have cast this Coldstream Guardsman in many lights, perhaps due to his sharp defeat and hasty retreat after meeting a force of about one-tenth of his own. Mr. McCardell has shown General Braddock as a man of his day and age who was no worse than many but perhaps braver than most. The reader has a feeling that the general was deserving of rewards of ambition which slipped his grasp and actually fell to those who failed and betrayed him.

Twenty-eight years later, after personally witnessing this defeat, George Washington, recalling the circumstances of General Braddock's death, wrote:

Thus died a man whose good and bad qualities were intimately blended. He was brave even to a fault, and in the regular service would have done honor to his profession. His attachments were warm; his enmities strong, and having no disguise, both appeared in full force. He was generous and disinterested, but plain and blunt in manner, even to rudeness.

This is a well-written book filled with interesting sidelights of the life in English courts and some details as to problems in military service during the period 1660-1755.

The author has included an excellent description of the march of the British Colonial force from Norfolk, Virginia, to the banks of the Monongahela. This book is a result of much research and is of value to students of history of that period.

MODERN RUSSIA. By John Long. 180 Pages. The Philosophical Library, Inc., New York. $6.00.

BY MAJ ROBERT H. ALLAN, JR., *CE*

This is a book of facts about modern Soviet Russia. It is addressed to the nonspecialist reader who requires broad, educational background information about the country where a political experiment is underway which affects the lives of every human on earth—either directly or indirectly.

The author's approach is interesting and his style easy and light. He sets up his subject by discussing the geography of Russia, and then moves quickly to a useful discussion of the peoples of the USSR —their origins and present distribution, similarities and differences, religion, culture, and social aspects.

The political system is discussed to include some of the personalities near the Party summit. This is tied to the planned economy, resources, problems, and prospects of the Soviets.

Finally, Mr. Long develops the position of the USSR in the world today with emphasis on the events since the death of Stalin.

Modern Russia is recommended for military leaders—particularly those students of the war potential of nations.

STATISTICAL YEARBOOK 1957. 674 Pages. Statistical Office of the United Nations, Department of Economic and Social Affairs, New York. $8.00 clothbound. $6.50 paperbound.

BY LT COL ROBERT M. WALKER, *Arty*

This two-language (English and French) publication of information collected by the Statistical Office of the United Nations provides 191 different tables of data on many subjects. It includes such subjects as population, agriculture, forestry, industrial production, and others.

This volume is a complete and authoritative compilation of vital statistics concerning virtually every nation of the world. However, in the case of Communist China and the Soviet Union, the information provided is somewhat limited.

THE WAR FOR INDEPENDENCE. A Military History. By Howard H. Peckham. 227 Pages. The University of Chicago Press, Chicago, Ill. $3.50.

BY LT COL MARK H. TERREL, *Inf*

A good many Americans and probably many Englishmen have found themselves wondering, how did it happen? How did the early American Colonies succeed in breaking loose from the power and possessiveness of the British Empire? How could a Colonial Army, dressed in rags, stand against the Redcoats who were the discipline of the Europe of their day? How could backwoods combat power stand up to the experienced regulars and competent mercenaries of the British Imperial Army?

This is not the type of military document in which the author purports to know the details of how the second squad of the umpteenth grenadiers went up the left side of the mountain while the first Georgia rifleman went up the other. Rather, it is an attempt to explain the economic, social, and military pattern of the day as they fitted together to produce the unforeseen catastrophe to the English colonial system. It does not seem possible, given the circumstances and the environment described at the start of hostilities, that the end product could be independence for the Colonies. Yet this appears to be the way it turned out and Mr. Peckham has done an excellent job of explaining how and why.

If you want the complete details of the colonial rebellion, this book tells you where to find them. If you want the summary of how it happened and why, and if you want to be able to explain to your children the answer to the simple questions of how did we get free, and how could Washington beat Cornwallis with the number of people he had, then this is the book you want.

SPACE RESEARCH AND EXPLORATION. Edited by D. R. Bates. 287 Pages. William Sloane Associates, New York. $4.00.

BY LT COL IRVING HEYMONT, *Inf*

In this age of *Explorers* and *Sputniks*, knowledge of space research and exploration is no longer the domain of only those who seek knowledge for the sake of knowledge and the addicts of science fiction.

This book fills a void in the literature of space research and exploration. It separates science from science fiction and provides the layman with essential knowledge of outer space and the associated problems of research and exploration.

Fully illustrated with charts and diagrams, it is, perhaps, the most comprehensive book yet published on the subject. It provides an authoritative and complete coverage, by outstanding British experts, on the conditions in space, motion, and propulsion and life in the absence of air and gravitation.

This simple historical record of what has been accomplished and a clear exposition of the problems to be solved to permit interplanetary travel deserves a place in the library of every alert military person.

MAJOR GENERAL JAMES HENRY CARLETON, 1814-1873. Western Frontier Dragoon. By Aurora Hunt. 390 Pages. The Arthur H. Clark Co., Glendale, Calif. $10.00.

BY LT COL HAROLD E. BEATY, *CE*

A hundred years ago the soldiers of the United States Army were the pioneers, protectors, and explorers of this country's vast, untamed area between the Mississippi and Missouri Rivers to the Pacific Ocean. In these early days when the hostile American Indian dominated the prairies, early settlers depended upon the Army troops to a great degree for their survival. The roles played by the soldier were important; yet frequently their efforts were minimized. They should have been well-known by their accomplishments, but many of the critical moments went unrecorded, were biased, or lost.

The author of this interesting and informative book has succeeded in weaving together a few strands of hitherto unpublished American history related to this period. By skillfully appraising the service of one soldier, James Henry Carleton, he provides a better understanding of the many problems that confronted the United States Army during these frontier days.

In contrasting General Carleton with his times, the author has filled this book with numerous historical and human interest accounts which surrounded this officer. During 33 years of highly eventful military service, General Carleton had a great variety of battlefield and staff experiences which marked him well for the positions he held. He was a man of strong moral courage and was well-respected.

The events covered include the Maine Boundary Controversy (1893); the many marches into Indian country from Fort Leavenworth, Kansas; the Battle of Buena Vista, Mexico (1847); the settlers massacre by Morman-led Indians, near Salt Lake City (1857); and Civil War action in New Mexico, Arizona, and California.

Perhaps the most interesting account is that of the trials, tribulations, and problems which plagued General Carleton as Military Commander of the Territory of New Mexico during and after the Civil War.

This well-written and informative book contains much authentic information which is of value to the student of American military history and frontier life.

THE MEMOIRS OF GENERAL WILLIAM T. SHERMAN. By Himself. Introduction by B. H. Liddell Hart. Two volumes in one. 405 and 409 Pages. Indiana University Press, Bloomington, Ind. $8.00.

BY LT COL FOSTER F. FLEGEAL, *Armor*

General Sherman—soldier, teacher, and, strangely enough, the writer of a piece of military history that no student of the Civil War can afford to miss—describes the United States of the middle 1800's. Through a portrayal of the life of a US Army officer in that period, he shows us the experiences that molded the men who were to become the leaders in the Civil War.

Sherman, who writes like he fought—hard, tough, and pulling no punches—gives a detailed and straightforward account of those portions of the war in which he participated or of which he had personal knowledge. He tells the action as it happened, accepts responsibility for his errors, lays the blame where necessary, and gives all credit for his success to the magnificent soldiers who fought under his command.

This book is not only an outstanding piece of Civil War history, but also a magnificent treatise on leadership written by one of the great leaders of all time.

The reader who is not familiar with the terrain of the Civil War campaigns may find it difficult to follow the text since the book includes no maps.

SOLDIERS, THE FIGHTING DIVISIONS OF THE REGULAR ARMY. By Bruce Jacobs. 367 Pages. W. W. Norton & Co., Inc. $5.95.

BY LT COL RODGER R. BANKSON, *Inf*

The author of *Heroes of the Army: The Medal of Honor and Its Winners* is a competent historian, well-grounded in military affairs—and knows how to write. In this effort he has selected a broad, but excellent subject of great interest. A lot of people are going to like this book and are going to budget for it under the heading of "essential reference material."

The book is worth buying for the first chapter alone. Into it the author has compressed the results of a major research effort. He traces the origin, organization, numbering systems, and scenes of action of the Regular divisions of the US Army. Thereafter, in numerical order, these divisions march, ride, and fight through the remaining 20 chapters.

The last page or two of each chapter is, like the first chapter, a gold mine for the military man who wants facts in the form of places, dates, and names.

It is obvious that the author's problem lies in the size of the subject he has selected. Even though he limits himself, subjectwise, to the 20 Regular Army divisions, 367 pages permit no more than a thumbnail sketch of a division's history. Accepting a limitation which permits, for instance, only 20 pages to outline the 2d Infantry Division's participation in three major wars, the author loads his discussions with facts and sufficient descriptions of individual and unit actions to show what kind of a war the division fought on various occasions. The member or former member of one of the subject divisions will wish these descriptive portions could be longer and in greater detail. But the author did everything he could, considering the space available, and did it well.

This is a book about proud fighting men and it does nothing to hurt their pride—in fact, any man who reads this book will gain increased pride in his own division and a fraternal feeling toward the other equally great fighting units of a tough profession.

HUMAN RELATIONS AND POWER. By Albert Mueller-Deham. 403 Pages. The Philosophical Library, Inc., New York. $3.75.

BY LT COL JEAN P. MESLET, *French Army*

This book makes a significant contribution to sociology and the science of politics.

The first part is a treatment of general sociology in itself which builds the foundation for the rest of the book. The second part presents the factors which influence social processes. By a synthetic presentation it brings to light the great variation in the different forms of power in the social sphere.

These first two parts try to bring out the permament factors of sociology. They do not pretend, however, to enable the reader to forecast events by means of sociological research, but rather to understand them better and to discover norms, regulations, and social laws.

The third section is devoted to general political theory and deals in its last chapters with the advantages of a "sociological equilibrium." A short fourth part applies sociological thought to the ethical problems of "earnest personalities having honest convictions."

The author's intent is to introduce a new theoretical treatment of human relations, power, and politics. The work is an attempt to break with the prevailing tendency of American sociology to dismiss theoretical aspects of this science.

This thought-provoking book will be of great interest to military readers in an era of spiritual unrest, political upheavals, and ideological warfare.

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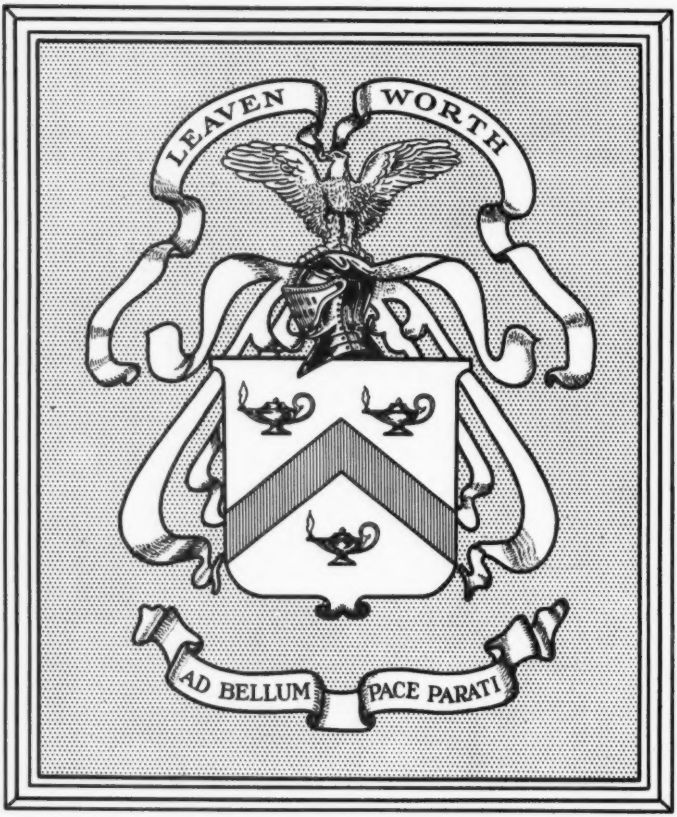
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